8. JUNE, 1909. No. 2.

# Rensselaer Polytechnic Institute Bulletin.

## THE FORMAL OPENING

OF THE

## RUSSELL SAGE LABORATORY

DESCRIPTION OF THE LABORATORY

## COMMENCEMENT ADDRESS

AND

TITLES OF GRADUATING THESES

TROY, N. Y.
June, 1909.

Published Quarterly in March, June, September and December at Troy, N. Y., by the Rensselaer Polytechnic Institute.

Entered January 20, 1902, at Troy, N. Y., as Second Class Matter under the Act of Congress of July 16, 1894.

THE Rensselaer Polytechnic Institute was established in 1824 as a School of Natural Science. A Course in Civil Engineering has been given since 1835. Courses in Civil, Mechanical and Electrical Engineering and in Natural Science, leading to the degrees Civil Engineer (C. E.), Mechanical Engineer (M. E.), Electrical Engineer (E. E.) and Bachelor of Science (B. S.) are now given. Also various special courses in Chemistry, Drawing, Surveying, etc., not leading to a degree.

# Rensselaer Polytechnic Institute

Founded 1824

---

# THE FORMAL OPENING

OF THE

# RUSSELL SAGE LABORATORY

With a Description of the Laboratory and Illustrations
Showing Exterior and Interior Views of the Building.

---

## THE COMMENCEMENT ADDRESS

AND

THE TITLES OF THE GRADUATING THESES
ALSO ILLUSTRATIONS SHOWING SOME
OF THE FACULTY AND STUDENTS



Troy, N. Y.
June 15–16, 1909

# TABLE OF CONTENTS.

---

## FORMAL OPENING OF THE RUSSELL SAGE LABORATORY.



## COMMENCEMENT EXERCISES OF THE CLASS OF 1909.

# LIST OF ILLUSTRATIONS.

Russell Sage

Margaret Olivia Sage.

View of Sage Laboratory from the South-West

# THE FORMAL OPENING OF THE RUSSELL SAGE LABORATORY.

The formal opening of the Russell Sage Laboratory took place June 15, 1909. The exercises consisted of introductory remarks by Palmer C. Ricketts, President of the Institute, and addresses by Robert W. De Forest of New York city, who represented Mrs. Sage, Jesse M. Smith, President of the American Society of Mechanical Engineers, and Lewis B. Stillwell, President-elect of the American Institute of Electrical Engineers.

Introductory remarks by Palmer C. Ricketts:

" LADIES AND GENTLEMEN.— We are here to-day to formally open the Russell Sage Laboratory which has been built recently with part of a fund given last year by Mrs. Russell Sage as a memorial to her husband, who died in 1906. In a letter dated January 21, 1907, Mrs. Sage said:

" ' DEAR MR. RICKETTS.— I have told you of my intention to give one million dollars to the Troy Polytechnic, and I know, from my conversation with you and from what Mr. Robert W. DeForest has reported to me of his interview with you, the general purposes for which you intend to use it.

" ' I will immediately send you my check for $100,000. If it does not accompany this letter it will follow it and I shall be ready to pay the balance, upon your request whenever it may be needed, at any time after May 1, 1907.

" ' I write this letter so as to make my gift, to which I attach no conditions, a personal obligation upon me, and in the event of my death before consummating it, upon my estate. It is right that you should have such a letter before you begin to make your plans.

" ' I am quite willing that this gift should be announced pursuant to your desire at the meeting of your trustees and of your alumni, to be held, as I understand, some ten days hence, and to leave the form of announcement to you, except that in making the announcement I should like to have the fact of my own and Mr. Sage's previous relations to and interest in the Polytechnic made apparent, as a reason for the gift, and as differentiating the Polytechnic

View of Sage Laboratory from the North-East. Boiler House

from other institutions who have made applications to which I have not responded, and with which neither Mr. Sage nor myself had any personal or official relations.

Sincerely yours,

MARGARET OLIVIA SAGE.'

"Both Mr. and Mrs. Sage had been interested in Troy institutions for many years. Mrs. Sage was graduated at the Emma Willard School. Mr. Sage's nephew, Russell Sage, 2d, was graduated at the Institute in the class of 1859 and Mr. Sage himself was a member of the Board of Trustees for ten years, from 1896 to 1906.

"In fact a considerable part of Mr. Sage's life was spent in Troy. His early business experience was obtained here. He was elected to Congress from this district and served two terms from 1854 to 1858. In 1863 he moved to New York and began the business career which afterwards placed him among the greatest financiers of the country. During this career he was president of more than twenty corporations. He was especially interested in the development of the transportation systems of the country, was a promoter and manager of railroads and at the time of his death a large part of his vast wealth was invested in railroad securities.

"One of the most important events in the history of the Institute, with the exception of its foundation, was its reorganization in 1849–50 by that very able director B. Franklin Greene. In a remarkably interesting review of the whole subject of scientific education abroad, published in 1855, he clearly stated the object of the reorganization as follows:

"'Its objects were thenceforward declared to be "the education of architects and civil, mining and topographical engineers upon an enlarged basis and with a liberal development of mental and physical culture," and again, "and now it may be proper here to state in another form the objects originally proposed in the reorganization of the Rensselaer Institute. These objects were to develop the original and peculiar excellencies of this institution into a true polytechnic establishment on a liberal basis and with elevated aims.'

"Separate courses in topographical engineering and in mining engineering were shortly afterwards established and some of the most eminent and successful of our alumni were graduated with the degree of mining engineer. The curric-

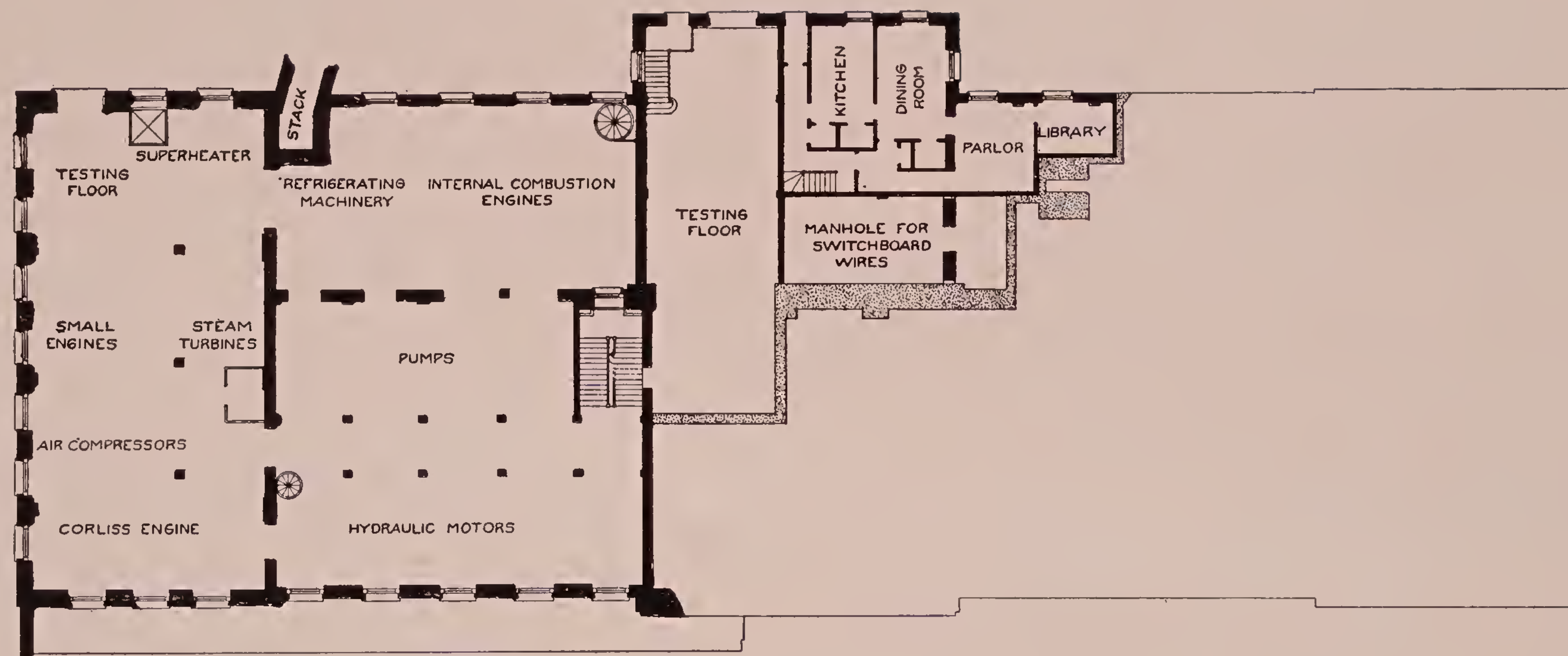
Athletic Field, Club House and East End of Sage Laboratory

ulum for a course in mechanical engineering was also printed in the catalogue for several years, though this course was never really established. It was soon recognized that the financial condition of the school did not permit the proper equipment and support of such courses and development upon the broad lines outlined by Director Greene was for a while arrested.

"In the first paragraph of the letter of Mrs. Sage reference is made to the general purposes to which the gift was to be devoted. Ever since Mr. Sage had become a trustee I had taken occasion at intervals to tell him that we greatly needed a school of mechanical engineering. With an intimate knowledge of the history of the school and of the great work it had accomplished, I nevertheless realized that it was a school of civil engineering only and not a polytechnic institute. Furthermore I thoroughly understood that recent enormous advances in mechanical and electrical engineering rendered additions to our curriculums and equipment imperative if we were to remain among engineering schools of the first rank. I believed that this enlargement of the field of the mechanical and electrical engineer was to continue in the future, as it had in the past few years, in geometrical rather than in arithmetical progression and that it was not possible to inaugurate a single curriculum, of a practical length, that is of four or even five years' duration which would even now give a student a proper preparation for the practice of these three branches of engineering, leaving out of question the certain increased requirements of the future.

"I believed the time had now come to lay the foundation for a 'true polytechnic establishment' by the addition to the existing two courses in civil engineering and science of two more engineering courses which would be followed, I expected and expect, by post-graduate schools to which all these are a necessary pre-requisite. After an interview with Mr. Robert W. DeForest, the adviser of Mrs. Sage, during which these views were explained at length, I wrote him on November 18, 1906, a letter containing the following paragraph:

"'It is a very great school of civil engineering, and it needs most a school of mechanical and electrical engineering to round out its work. This should most properly be called the Russell Sage School of Mechanical Engineering, and it would form a memorial to Mr. Sage, and to Russell Sage, 2d, C. E., who was graduated in the




SUB-BASEMENT PLAN
SAGE BUILDING · RENSSELAER POLYTECHNIC INSTITUTE ·
TROY N.Y.

class of 1859. It would be a perpetual memorial of enormous educational value.'

"The faculty of the Institute concurred in these opinions and at a meeting held January 26, 1907, it was

"Resolved, That in the opinion of this faculty the establishment of schools of mechanical and electrical engineering would be advisable and would be of great benefit to the school, provided the board of trustees has at its disposal sufficient money to properly inaugurate such schools.

"Resolved, That in the opinion of the faculty the usefulness of the school would be enlarged if it were a true polytechnic institute and not as at present practically only a school of civil engineering.

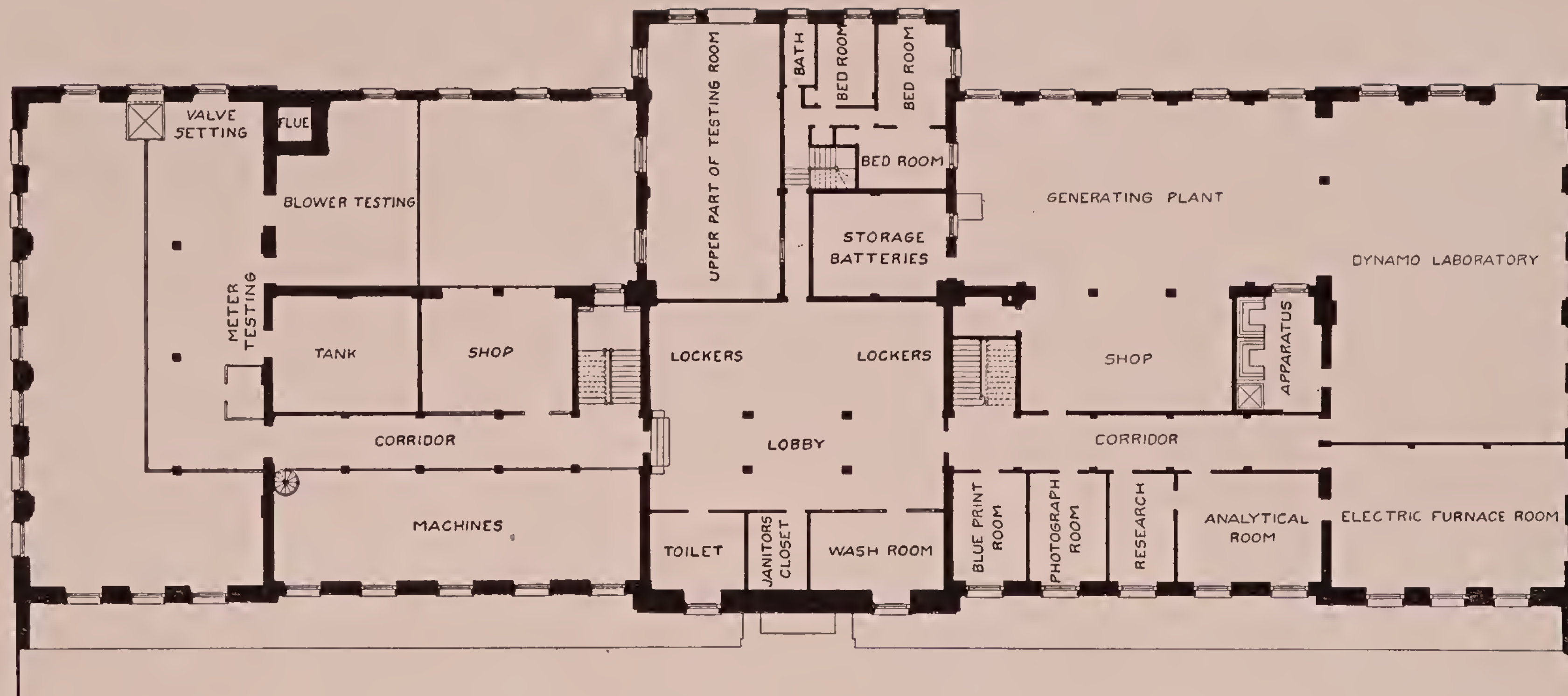
"Resolved, That we believe the establishment of well equipped schools of mechanical and electrical engineering would be a long step towards changing the school into a true polytechnic institute.

"At a meeting of the Board of Trustees held March 14, 1907, it was

"Resolved, That courses in mechanical and electrical engineering, leading to the degrees, Mechanical and Electrical Engineer, be established at the institute, and that a committee consisting of the Prudential Committee, Vice President and Treasurer of the board be appointed with power to do whatever may be necessary to inaugurate such courses.

"The schools being thus established, mechanical and electrical laboratories were necessary and in consequence the Russell Sage Laboratory was constructed. It speaks for itself. And it speaks also not only for the taste and constructive ability of the architects, Messrs. Lawlor and Haase of New York, but for the great practical knowledge and high sense of duty of Dr. W. L. Robb and Professor A. M. Greene, jr., who are responsible for the general arrangement of rooms and the equipment of the structure. The building and contents are valued at $405,000. Of this amount $300,000 of the million she gave us were taken from the donation of Mrs. Sage and the remaining $700,000 have been placed, by resolution of the Board of Trustees, in a Russell Sage fund to be kept forever intact and used as an endowment for the department of mechanical engineering.

"Such is the history of this great gift and of the purpose to which it is to be devoted. On behalf of the Board of Trustees, Faculty, Alumni and other friends of the school




BASEMENT PLAN

- SAGE BUILDING RENSSELAER POLYTECHNIC INSTITUTE

TROY, N.Y.

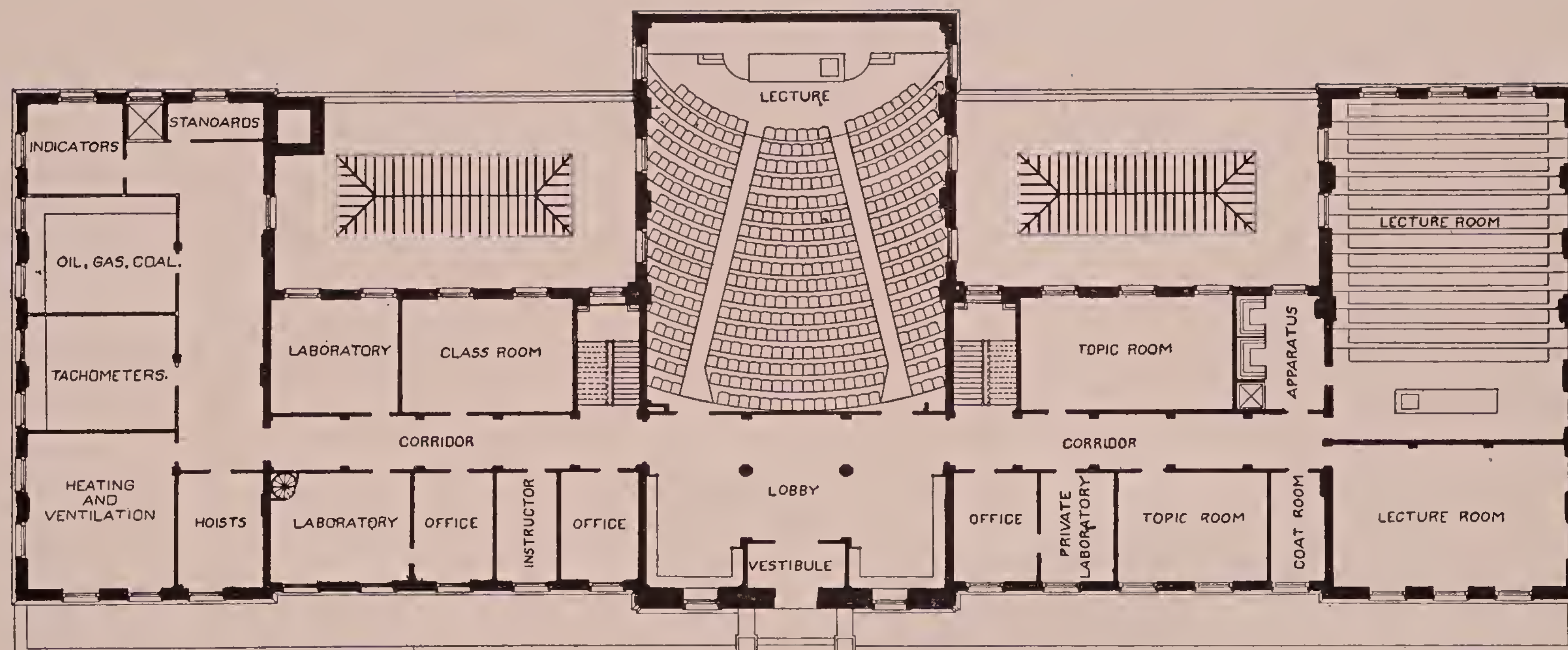
I hereby publicly acknowledge our great gratitude to the donor. Nor can I refrain from expressing admiration for her sound judgment, determined purpose and splendid Christian character shown by donations for educational and charitable purposes which, while they will forever perpetuate the name of her husband, will not the less be monuments to her intelligence, her discrimination and her altruism."

Address of Mr. Robert W. De Forest:

"Mr. Chairman, Graduates and Friends of the Rensselaer Polytechnic Institute. — This is the first time I have been in Troy at this institution. I have had the pleasure of sitting awhile at your alumni meeting and noticing the spirit of democracy and informalism with which that meeting was characterized, and being a Yale man I find myself singularly at home.

"Now, I am here to represent Mrs. Sage and to express her appreciation of the way in which her gift to this institution has been used, and I may say also I am here a little to represent myself, because I want to speak a little independently. There are several features which characterize Mrs. Sage's gift to Rensselaer. In the first place it came unasked; and I must beg President Ricketts' pardon; he did not apply; it was Mrs Sage who applied to him for preliminary information about this institution before she carried out her purpose. In that respect it was not like the relation of Mrs. Sage to other institutions, educational and otherwise. There were some who did not wait delicately, as this institution did. Another point is, that having received a million dollars, Rensselaer did not ask for more. In that respect it is unlike some other institutions and not having asked either originally or for more, Rensselaer has received as large a gift as Mrs. Sage has made to any educational institution. So modesty has its own reward. It came very appropriately to an institution connected with the city with which she herself and her husband had been long connected, and it came to an institution that deserved it and has used it wisely.

"There is a remarkably broad range in Mrs. Sage's gifts — whether it be in taking nuts to the squirrels in Central Park, or feeding the birds there, or whether it be in giving each one of the laborers in Central Park a little Christmas gift, or whether it be filling that park with rhododendrons for the benefit of the public of New York city, or in restoring the governor's room in our city hall, or in a



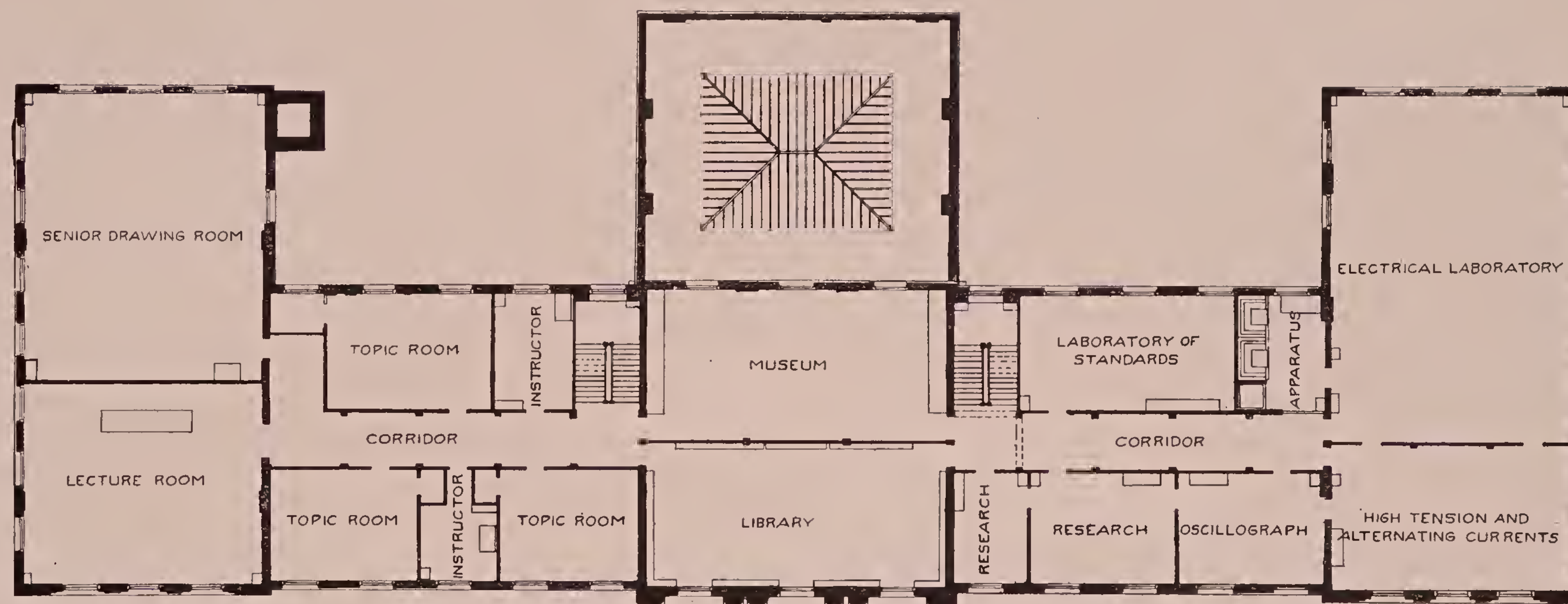

FIRST FLOOR PLAN

- SAGE BUILDING - RENSSELAER POLYTECHNIC INSTITUTE -

TROY, N.Y

gift to an institution of learning like this, or in a gift to the nation such as she made of Constitution Island — they all come from one root, one keynote of human sympathy, and that is one reason why it must be pleasant and grateful for any institution to receive something from Mrs. Sage, and she will be particularly pleased with one application which has been made of this gift. Now I am speaking of that magnificent building which bears the name of her husband unasked, because there was no string to her gift, no condition; she asked for no memorial. She did, as givers can wisely do when they give to wise trustees, and they should not give to any others; leave these trustees absolutely untrammeled in what they should do with the money placed at their disposal. In that respect it is a model gift to a scientific or collegiate institution. But there is one particular feature in the way in which her money has been used which I know is very grateful to her, and that is in a part of it being used to increase the salaries of the professors and a little of the president's.

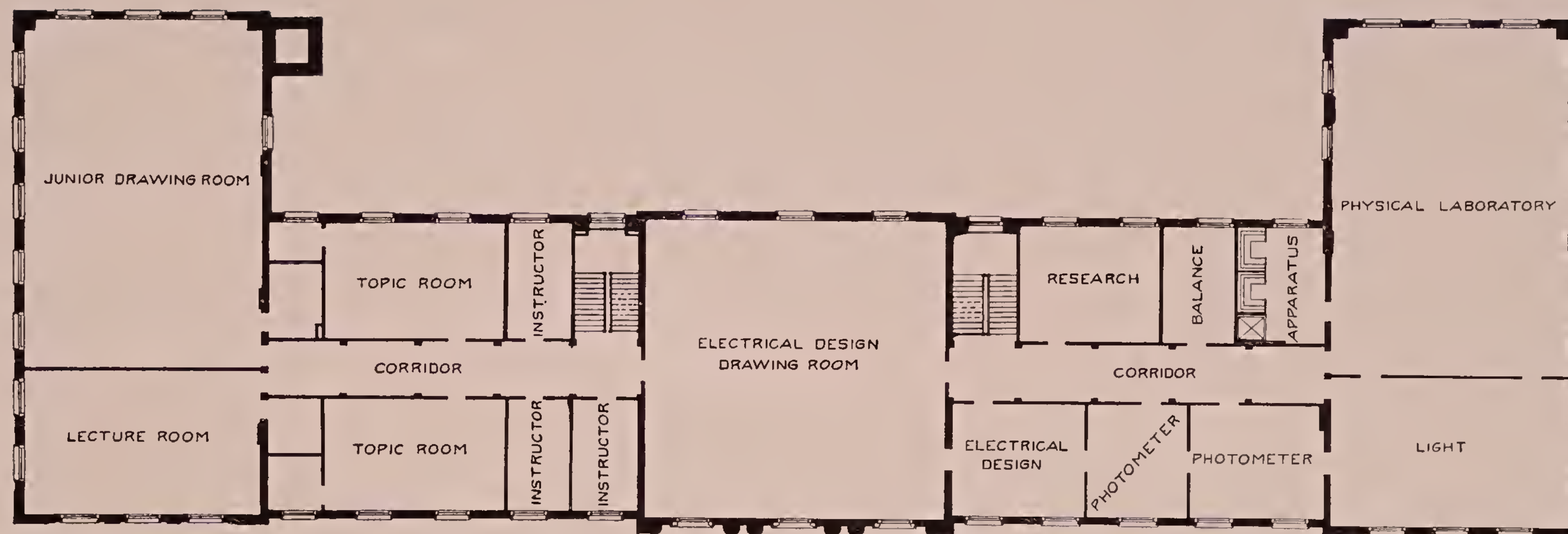
" I was impressed when I first met President Ricketts and asked him some questions, with the fact when he told me that your professors as a rule were receiving no more than $2,400 or $3,000 and that the salary of the president was not very much above that figure. Now, that is a piece of self-denial on the part of president and professors that in these days ought not to continue. Twenty-five years ago I know that was not singular to our institutions of learning and I know it is not singular to many of our institutions even now, though it ought not to be, but the standard of living has changed, the standards up to which professors and presidents have to live has risen and I was amazed to find that in an institution of this standing and this age and this reputation within a few years that extraordinary low standard existed. Your president in his very flattering remarks has brought to my mind an illustration with regard to the rise in the standard of living. I did serve on the Tenement Commission of 1900 and I had the pleasure of serving with one of your alumni, Alfred T. White, whom I see here, and one of the questions brought before us was whether as a legal obligation we should not compel builders of tenement houses to put in baths. I declined to do so as a matter of legal obligation, but we hoped that many enlightened owners in response to a natural demand would do so. I afterwards served as head of our Tenement Department for two years and was greatly surprised to find in casting up accounts, I do not mean




SECOND FLOOR PLAN
SAGE BUILDING RENSSELAER POLYTECHNIC INSTITUTE
TROY, N.Y.

figures, accounts of work done at the close of my administration, that out of all the tenements built during these two years under this new law, without any obligation whatsoever on the part of owners to put in baths, and thus a hundred million dollars was spent in the city of New York, more than ninety per cent of the apartments in these tenements had baths. The standard of living in New York tenements had been raised to such a point as to create a demand which enlightened owners thus sought to recognize and profit by. I was so impressed with this that when I went to my college commencement at Yale and met our venerable President Dwight he asked me how the tenement proposition was getting along, I told him this fact as illustrating the rise in the standard of living and I said 'I graduated from college in 1870, we are now in 1903. When I was in college I don't remember a single student in Yale who had a room with a bath and there were only four baths for all Yale university located in the basement of the college gymnasium.' He smiled and said, 'De Forest, you think that is a great rise in the standard of living. I graduated in 1849, just twenty-one years before you did. When I was in Yale there wasn't a single student but had to go with his bucket to the college pump and bring the water to his room, and there wasn't a single student that did not have to empty his own slops, and when I became a tutor in 1850 and with some of the younger officers of the faculty proposed that there should be an innovation in this particular and that a single solitary colored man should be employed to go to the college pump and bring the water to the students' room and empty their slops, we were opposed by all the members of the faculty who were old on the grounds that it was a luxurious innovation and detrimental to students' independence. But we carried the question of water carrier by a vote of one. Now, what do you think of the rise of the standard of living between your time and mine?'

"The standard of living has been so raised now that certainly every college professor and college president deserves a room with a bath. I hope this rise in salaries will not necessarily stop here. If we criticise Rensselaer at all it is that it is a little too modest in the expression of its wants. You need more buildings, you need more rise in your salaries, you want here the very best men; you have certain supreme advantages at Rensselaer; you are concentrating your educational efforts in certain direct lines on which you can concentrate them. You have in that




THIRD FLOOR PLAN
SAGE BUILDING - RENSSELAER POLYTECHNIC INSTITUTE -
TROY, N.Y.

respect an advantage over the great universities which are extending in this direction, but you have the increasing competition of these universities. Your object here is primarily study; you are competing with institutions who, some people think, as a primary purpose have the gratification of social ambition or opportunity for athletic supremacy. There is one criticism applied to one of our larger institutions of which I hope you will never be guilty. A doting father of a son who was entered as a freshman at a large university — I wouldn't say which one — visited his son after several months had elapsed and said, 'George, how do you like it?' Said he, 'Father, it is great, it is just great being in college here, there is only one thing they should change.' Said the father, 'George, what is that one thing?' Said he 'It would be perfect, father, if they only omitted all the literary exercises.' I know in this institution there is no proposition to omit all the literary exercises."

Address of Mr. Jesse M. Smith:

"LADIES AND GENTLEMEN.— When Stephen Van Rensselaer on November 5, 1824, founded this institute and stated its purpose to be, '*the application of science to the common purposes of life*,' he laid a foundation broad enough and deep enough upon which to erect a university of technology. We learn from the history of R. P. I. by Professor Ricketts, however, that it was modestly called the 'Rensselaer School,' and the Board of Trustees publicly announced that the school was prepared to give 'instruction in chemistry, experimental philosophy and natural history with their application to agriculture, domestic economy and the arts; and also for teaching land surveying.' There were two professors, Amos Eaton, professor of chemistry and natural philosophy and lecturer on geology, land surveying, etc., and Lewis C. Beck, professor of botany, mineralogy and zoology. There were twenty-five students. The degree of bachelor of arts was given after one year and master of arts at the end of a second year of study. Much attention was given to field and laboratory work; in fact a circular issued in 1826 stated that the school was 'limited to an *Experimental Course in Natural Science*,' and it was confined principally to botany, geology and mineralogy.

"After nine years, in 1833, the name was changed to 'Rensselaer Institute,' With this higher sounding name came an effort toward higher education, and in 1835 there was established 'a department of mathematical arts. for

View of Campus West of Sage Laboratory

the purpose of giving instruction in engineering and technology.' At that time the degree of civil engineer— C. E. — was established and was given to eight graduates in the department of mathematical arts; eleven years after the founding of the school. The course of study still covered only forty weeks of one year, and there were only three professors and one assistant. A circular issued in 1835 said: 'One year is sufficient for obtaining the Rensselaer degree of Civil Engineer, for a candidate who is well prepared to enter. Graduates of colleges may succeed by close application during the twenty-four weeks in the summer term.'

Of the forty weeks required by this course, the mornings of four weeks were devoted to 'extemporaneous speaking on the subjects of logic, rhetoric, geology, geography and history,' and the afternoons to composition, exercises in various mathematical arts, and national and municipal law. What would the graduate to-day think of securing his degree after only forty weeks of work and giving ten per cent of that time to oratory, composition and the law? There is no doubt, however, that the graduates from all the technical schools of this country sadly need more training in English composition and rhetoric than is now given them.

"After another period of eleven years, another epoch and a long step forward was made, when B. Franklin Greene became senior professor in 1846. After a careful study of the scientific and technical institutions in Europe Professor Greene thoroughly reorganized this institution upon the basis of a general *polytechnic* institute, and it was then called the Rensselaer Polytechnic Institute. The managers resolved that 'their field should be narrowed and more thoroughly cultivated,' and their efforts 'restricted to matters immediately cognate to architecture and engineering.' The somewhat irregular and optional course requiring but a single year, was then superseded by a systematic and thorough curriculum requiring at least three years. As stated in a pamphlet issued at that time, the managers had 'no immediate expectation of realizing more than a very partial development of their plans' for a *poly*technic institute. They proposed first to develop the general, that is the common scientific basis of the professional courses, and then develop the two specialties of civil and topographical engineering and defer any attempt to develop other specialties until more favorable conditions could be realized. The new curriculum showed the effect of the study of the French schools. Its course considerably resembled the three years' course of l'Ecole Centrale des Arts et Manufactures, while

View of Campus South-West of Sage Laboratory

the part forming the ground work of the higher technical studies resembled the curriculum of l'Ecole Polytechnique. By the year 1854 the courses in civil engineering and natural science had been well developed. In 1857 the course in topographical engineering was added, but it was abandoned in 1866, only five men having taken the degree of T. E. In 1858 the four year course was established in civil engineering. In 1862 the course in mechanical engineering was added to those in civil and topographical engineering and natural science and all four courses were extended to four years, the first two years being the same in all. The course in mechanical engineering did not, however, materialize, and students who wished to pursue their studies in mechanical engineering were obliged to go abroad, there being no established schools in this country at that time teaching that branch of engineering. In this connection I am prompted by the kindly words of introduction of Professor Ricketts to say; that one of the regrets of my life has been that I did not remain with the class of '69 for another year and take my degree in engineering at R. P. I. before going abroad.

"I may also say; that had there been in '69 such a course in mechanical engineering as exists at the Institute to-day, there would have been no necessity for students going abroad to study Mechanical Engineering. I may add, however, that a study made at any time, of engineering abroad cannot fail to be of very great benefit to engineering students as well as to engineers. It is well to know how engineers, in other countries, think and how they work. The course in topographical engineering having died in 1866, a noble effort was made in that year to establish a course in mining engineering under the able direction of Professor Maynard, but it succumbed in 1871 to adverse conditions, after graduating twenty-three men. The same fate befell the course in natural science, so that in 1871 there remained only the course in civil engineering to represent the *general polytechnic school* which was the dream of Professor B. Franklin Greene. While the institute in 1871 ceased to be a *poly*technic institute except in name, it was still an excellent school of civil engineering, and has grown in excellence and importance as a school of civil engineering from that day to this.

"The Rensselaer Polytechnic Institute, however, has a higher destiny than the education of men in a single branch of the profession of engineering. Van Rensselaer laid a broad foundation for a general polytechnic institution.

View of Campus South of Sage Laboratory

B. Franklin Greene designed and organized a complete superstructure to be placed on that foundation, but only succeeded in building a portion of it. The present director by his individual energy, by his tact in interesting other members of the faculty, and by his ability in causing friends of the institute to appreciate its needs, has succeeded in preserving the good work done by his predecessors and has added to it, until now there are three courses in engineering where but one existed before. Who will complete the noble design and bring about a realization of the dreams of the founder and the organizer of the institute? A University of Technology, a *true* General *Poly*technic Institution. My appeal to-day is for a *University of Technology*.

"In this eighty-fifth year of growth of the Institute, mechanical engineering as a branch of the profession has finally been recognized, and in a worthy manner. Friends of the institution realizing and appreciating the good work which it has done in one branch of engineering have considered it worthy to undertake work in other branches of the profession, and they have shown their appreciation by making possible these splendid buildings filled with the latest and best apparatus to aid a fine corps of professors in the education of engineers in several branches of the profession. The Institute now takes its rightful position with other institutions, founded many years later in this country, in the education of mechanical engineers.

"No engineering work of importance can progress far without the mechanical engineer. Is there a railway to be built; the Civil Engineer makes the reconnoissance and surveys and lays out the line; the Mechanical Engineer designs and builds the dredges, steam shovels, rock drills, air compressors, the track laying machinery for building the road, and constructs and erects the bridges. Before the rails can be laid they must be made—by the co-operation of the Mining, Metallurgical and Mechanical Engineers. The railway, even after it is built, is of no commercial value until the Mechanical Engineer has designed, constructed and put into operation the locomotives and cars upon it. Is a mine to be developed; the Mechanical Engineer designs and builds the hoisting and pumping machinery as well as the crushing, ore handling and dressing machinery. Is a water power to be harnessed and transmitted by electricity; the Mechanical Engineer designs and builds the machinery for excavating the dam foundation as well as that for handling the material for erecting the dam; he designs and builds the turbines that convert the water

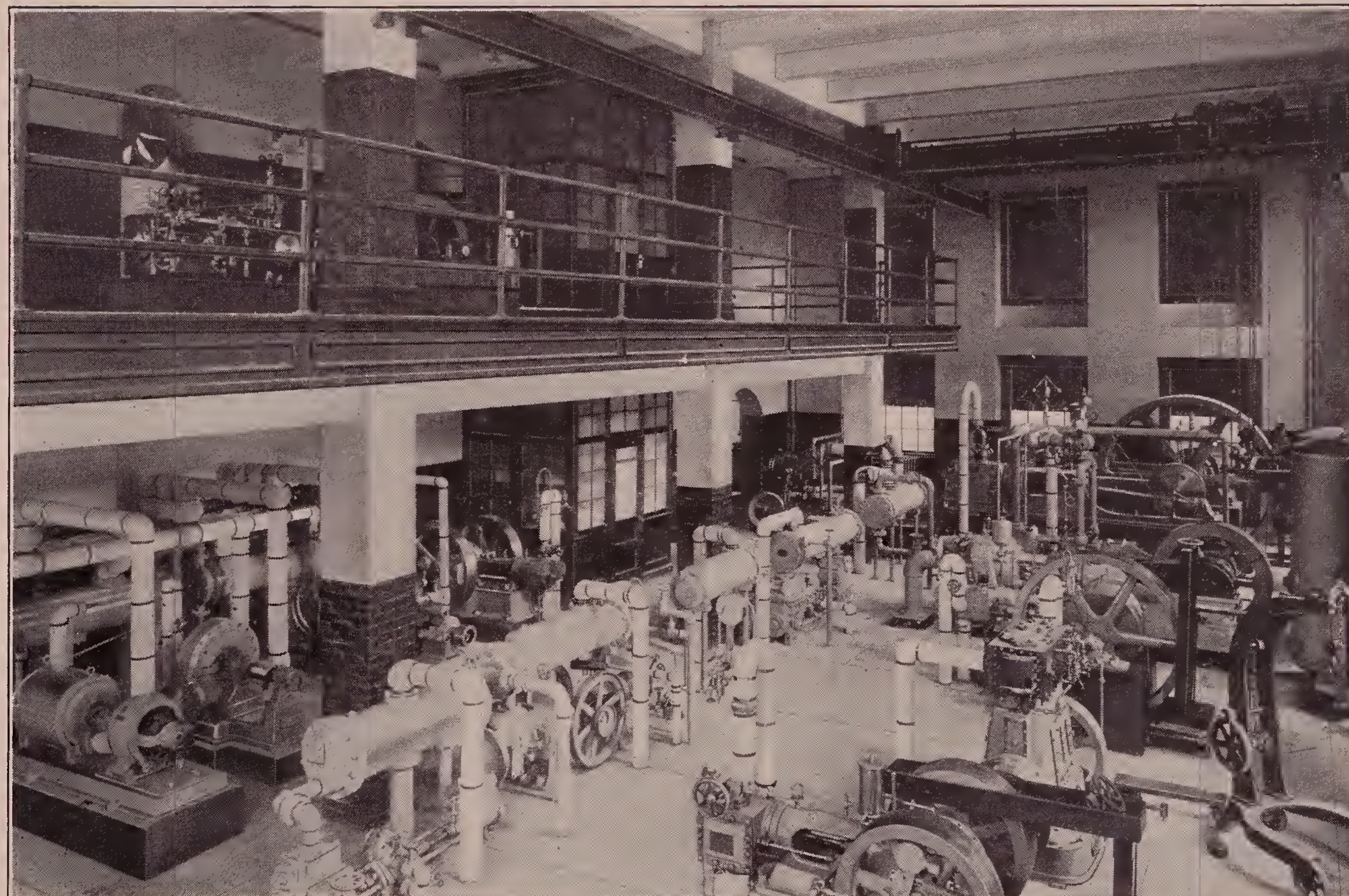
Large Lecture Hall, Sage Laboratory

power into the mechanical power that drives the electric generators, and he co-operates with the Electrical Engineer in the building of these generators.

" Engineering has taken such an important part in the industrial activities of this country that no industry can hope to become important unless it be entrusted principally to engineers. The varied knowledge required in the management of the varied industries of the country has caused and inevitably will hereinafter cause the engineer of prominence to be more or less a specialist in one or more branches of the profession, but before any engineer can rise to eminence in any branch of the profession he must have acquired by study or practice, or both, a great deal of information in other branches. An engineer, however diligently and effectively he may do his work in his chosen specialty, who never even tries to look beyond his own circumscribed horizon, can never become a great engineer. The fields covered by the various branches of the engineering profession overlap each other in so many different directions that it is impossible to determine even approximately their various boundary lines.

" It is characteristic of the practice of the engineering profession that the engineer never knows what he is going to be called upon to do next. New conditions suddenly arise, an accident occurs; the engineer must decide quickly and accurately what is best to be done, and then do it promptly and surely. If the work to be done happens to be outside of his specialty and there is no one besides himself to call upon to do the work, he cannot be excused from doing it because he was not taught how to do that particular work while at school. If he has been well grounded in the principles of engineering while at school, he will not be surprised by, or feel himself incompetent to solve, any problems that may come up in his practice. If he be a good engineer he will solve those problems himself without calling in specialists except to work out details of the general scheme.

" The establishment of the courses of mechanical and electrical engineering in addition to civil engineering at the Institute simply means that the trustees and faculty have recognized the demand for a higher and broader education in engineering, and that the friends of the Institute have provided means permitting that demand to be realized. A student entering the Institute selects that course which at the time seems most attractive to him or which he has been pursuaded to take by his parents or friends or the



Steam Laboratory with Valve Setting Engine in the Gallery

professors or because his chum is taking the same course. He goes through the course, wins his coveted degree of M. E. or C. E. or E. E. and is launched into the practice of engineering. Whether he receives the degree of M. E. or C. E. or E. E. he cannot know in advance nor will it be well for him to know, that his practical work will be along the lines of that branch of engineering indicated by his degree. It often happens that a young man with an M. E. degree in his pocket is called upon to assist in making a railway survey, or a man with a C. E. degree finds himself trying to design a steam engine, or an E. E. graduate is ordered to report on a water power. These different courses of study leading to these various degrees are right and proper and very valuable to the young engineer; but no one of them should be considered superior to the others, and each should be so complete in itself that a graduate from either course would not be surprised or feel himself incompetent when called upon to solve an engineering problem which might be classed in the specialty of another course.

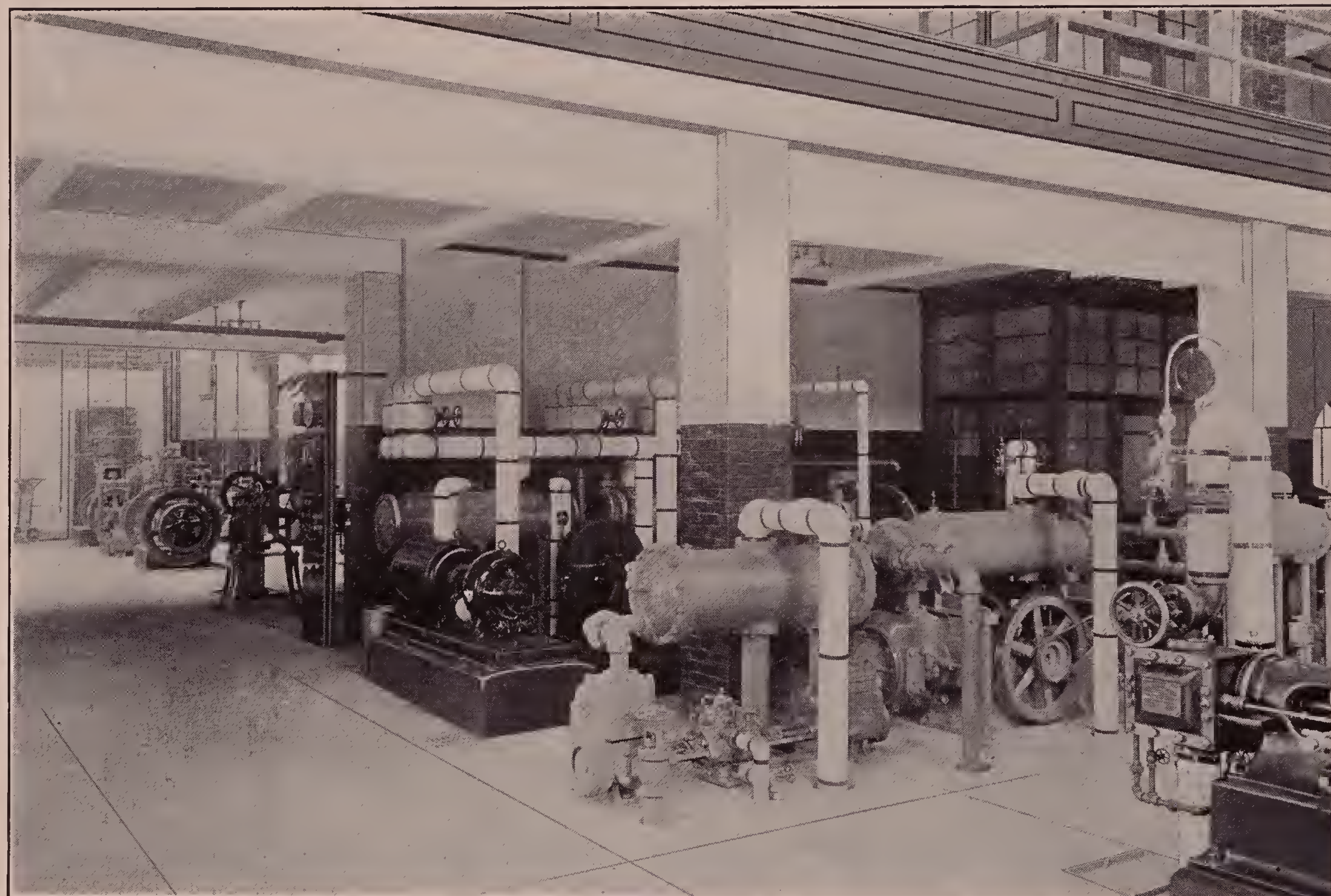
" After all, these various courses of instruction only constitute the *school* education of the young graduate in engineering; it is just the *beginning* of his education as an engineer. It teaches him how to think and reason accurately and correctly and informs him of possible sources of further knowledge. Every graduate from the Institute, whatever his degree, is entitled to, and should receive, the same fund of knowledge and information in order that he may start even with the others in the race for success in the profession of engineering.

" The instruction in engineering at the institute may be expressed by the following equation, using the degrees as symbols:

M. E. + C. E. + E. E. = School Education in Engineering.
The initial letter of each quantity of the first half of the equation may be canceled out, as a negligible quantity, leaving the equation:

E + E + E = School Education in Engineering,
and in my opinion every graduate is entitled to all of it.

"About sixty years ago B. Franklin Greene reorganized the Institute along the lines of a celebrated school of engineering in France. Forty years ago that French school was conferring degrees corresponding to the four degrees in this country of mechanical, civil, metallurgical and chemical engineer. The instruction was identical in all four courses. The application of that instruction, by the prep-



From Steam Laboratory into Gas Engine and Refrigeration Laboratory

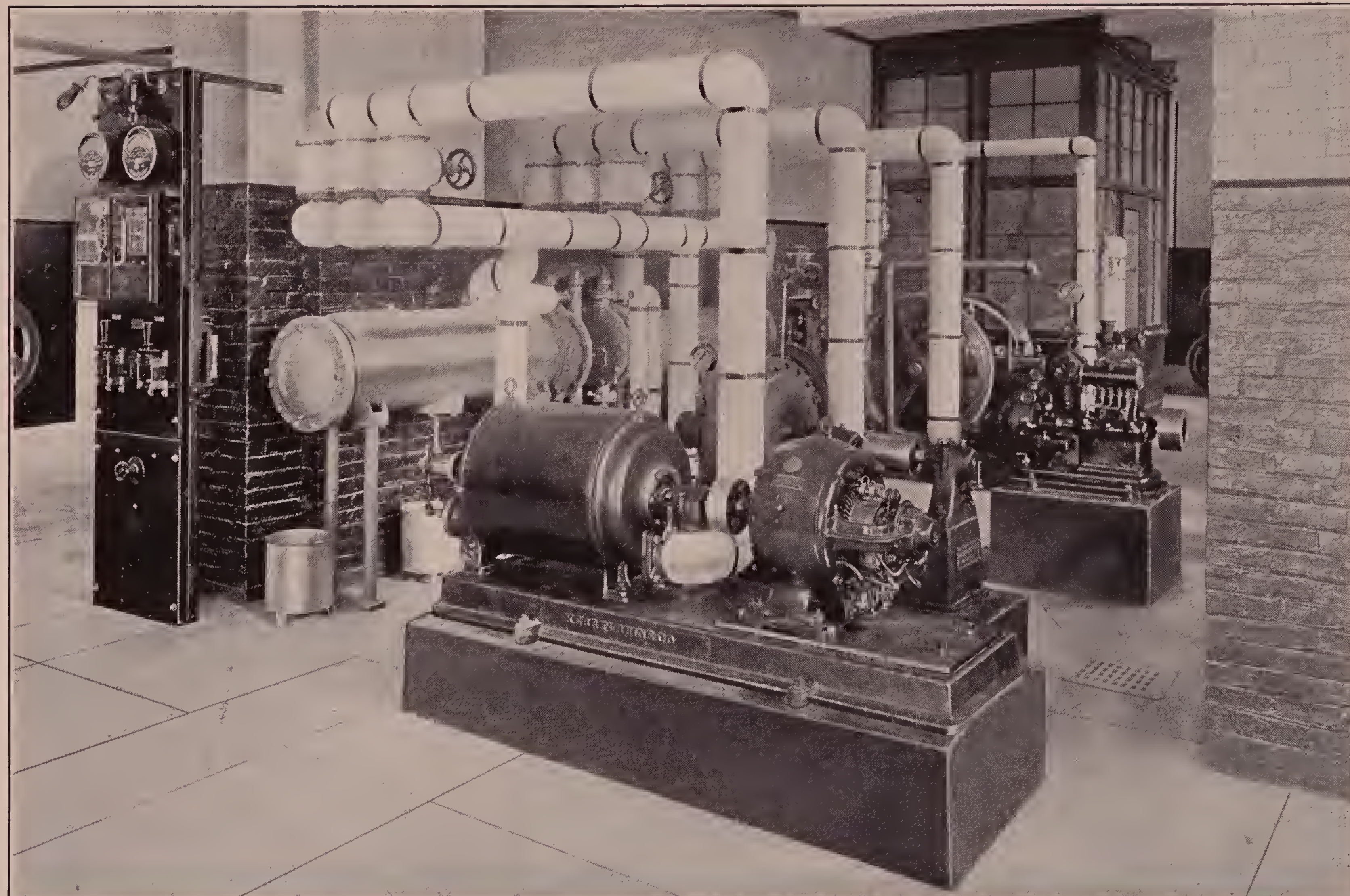
aration of a separate project or thesis every month of the last two years of study was along the lines of the specialty indicated by the degree. The diploma conferring the degree of engineer of arts and manufactures, at that time stated on its face the specialty in which the student had applied his instruction, but to-day the diplomas make no mention of the specialty; all are alike. Every graduate from that school has had the same opportunity to obtain his school education in engineering; all have begun their practice on the same basis, and all have applied their knowledge to such special work as came to them in their practice.

"Is it not possible that in the future demand for a still broader and more fundamental school education in engineering, at this Institute, will require that all graduates shall receive the same general degree in engineering and that after, say ten years of practice, when each graduate has discovered what his specialty is and what he is best fitted for, he may return to the institute and be examined for a degree in his chosen specialty? I hold for the *highest possible school education* for the engineer *without regard to specialty*."

Address of Mr. Lewis B. Stillwell:

"LADIES AND GENTLEMEN:—The dedication of a new hall of science is always an occasion of interest. The dedication of a splendidly equipped laboratory of mechanical and electrical engineering by that institution, which was the first civil school of science and engineering to be established in any English-speaking country, is an event of peculiar interest and far-reaching importance.

"The voice of America in this age is one of exultation. If it be assumed that the daily press speaks for our people it is not infrequently a voice of boasting. The press is not always discriminating in its estimate of the meaning of new steps and easily falls into the habit of exaggerating the value of a new thing and overestimating its probable results. The man in the street believes that we easily lead the world in science and in its practical applications, but those better informed know that we have strong rivals; that, while practice in America in mechanics and the electric arts compares favorably, as a whole, with that of any other country, the discovery of the facts upon which practice is based has been more often European than American. Even in the practical applications of physical science it happens not infrequently that we follow and do not lead. France led us in the development of the automobile.



Steam Turbines

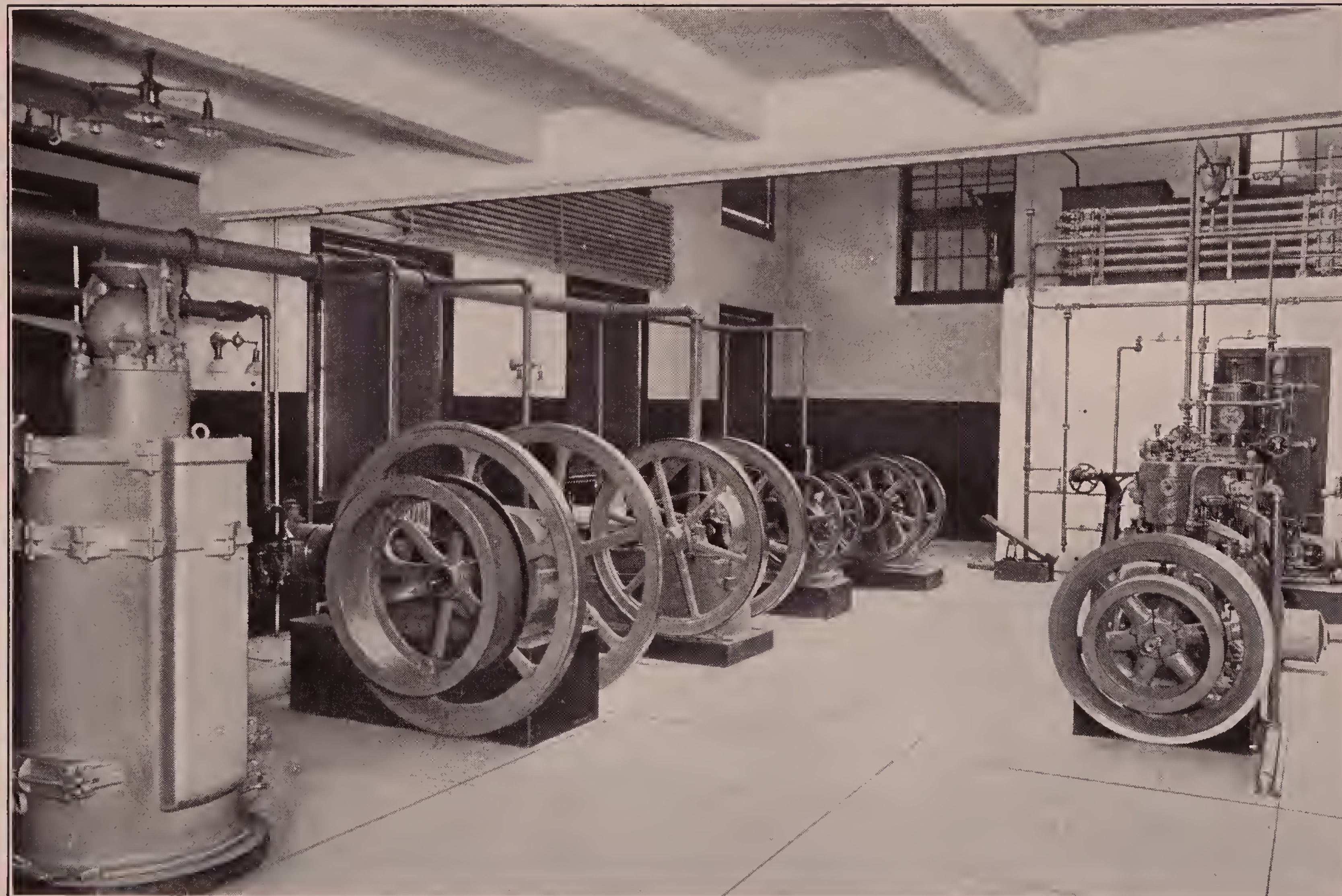
Thanks to the skill and daring of two young men from Ohio, an American aëroplane is now at the front, but Germany and France are showing the way in the construction and operation of dirigible balloons; Great Britain leads us, at present, in marine construction, and an Italian first developed, upon a practical and commercial scale, the utilization of etheric waves for transmitting intelligence, to the possibilities of which attention was first directed by the research of a great German physicist.

"The German empire to-day is a vast hive of industry organized in a manner of which comparatively few Americans who have not investigated the subject have anything like an adequate conception. In an interesting and very valuable paper upon 'Engineering Education,' read before the International Engineering Congress in St. Louis in 1904, Dr. Robert Fletcher, Director of the Thayer School of Civil Engineering, Dartmouth college, said: 'Realizing that even the most industrious people must have competent expert direction and that "efficient direction of any industry to-day demands a large amount of technical knowledge which cannot be learned at the bench or in the shop," the government and the people, through trade associations, have established hundreds of schools of applied science for instruction in all the leading industries of the empire and often many schools for the same industry.'

"In 1898 Professor J. B. Johnson, M. Am. Soc. C. E., reported that 'of 248 monotechnic schools in Prussia alone, more than half were voluntarily supported by various trades as schools for apprentices; in Saxony with 1,000,000 inhabitants were three monotechnic schools, besides ten schools of agriculture and forty of commerce; in Hesse, schools for agriculture and sculpture, nine for artisans, forty-three for industries and eighty-two for design. In Baden, schools of architecture, industry, commerce, etc.'

"German foresight and system in the organization of educational facilities not less than the industry and the frugality of the German people have advanced Germany within fifty years from a position of comparative poverty and obscurity to a place in the foremost rank of powerful and progressive nations. As Dr. Fletcher well says: 'It is not her army of soldiers which other nations need to fear, but her armies of scientifically trained directors of industrial enterprises and of highly educated commercial agents.'

"While no other nation to-day provides as effectively as do the Germans for enlargement of the boundaries of science by original research nor for the systematic training



Suction Gas Producer. Gas Engines. Refrigerating Plant

of its people in the industrial and commercial use of scientific facts and methods, there is very much that is admirable, effective and worthy of our most careful consideration in the educational, industrial and commercial practice of some of the other great nations.

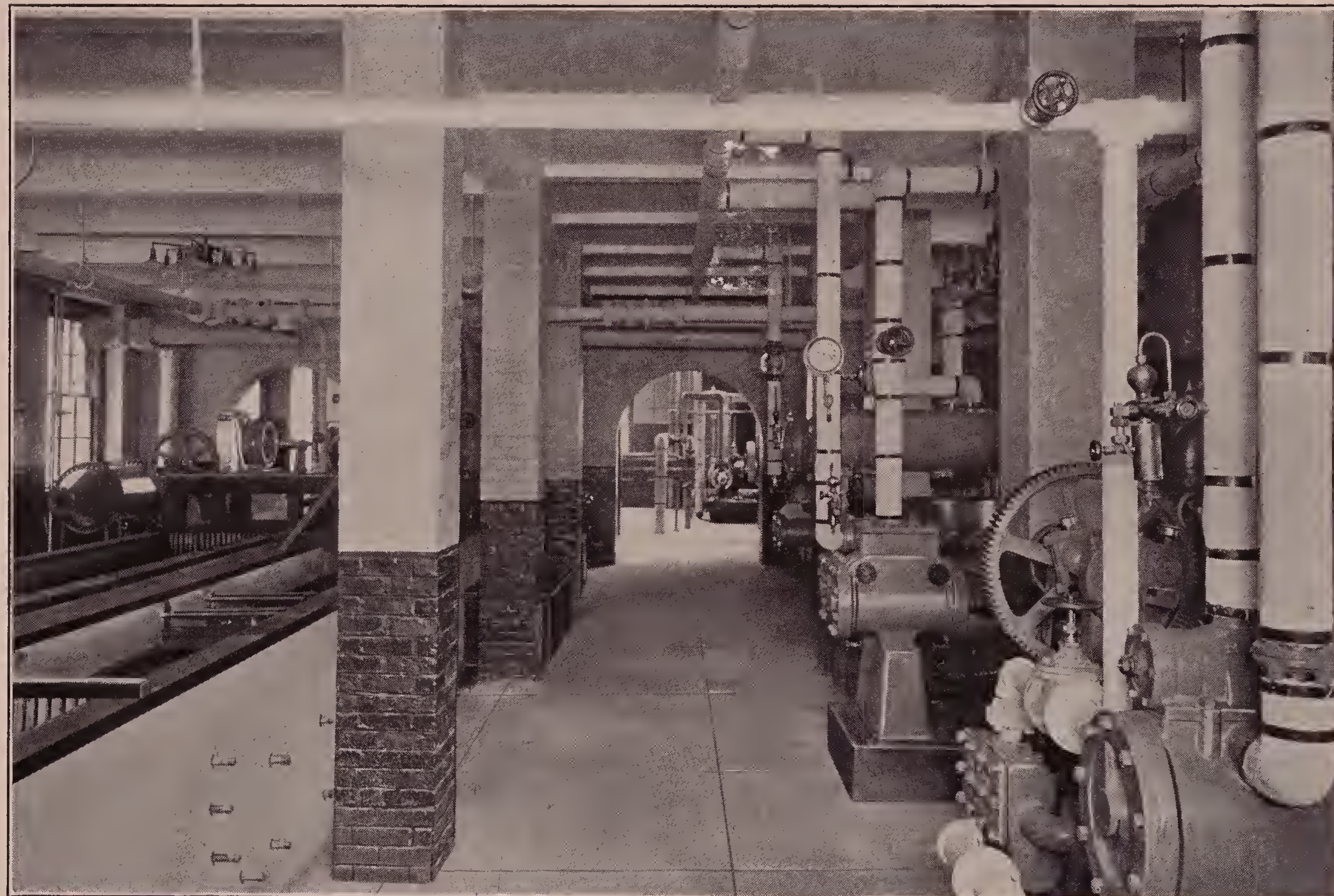
"The ratio of talent and skill to raw material employed in productive work is nowhere higher than in France. There are still many lessons in the fields of industry and commerce that we might learn to advantage by studying British achievement. The low countries, Switzerland and Italy, particularly northern Italy, are utilizing as never before the energy and skill of their people in applying the discoveries of physical science to the needs of modern life, but in Germany especially are the results of the physical and chemical laboratory evidenced by tremendous advance not only in material development, but also in intellectual activity.

"In 1866 there were in the United States six schools which taught engineering. The number to-day exceeds 100, and within the last decade or two, while the number of such schools has continued to increase, a far greater relative advance has been made in the endowment and facilities of the older established schools.

"An act of Congress passed July 2, 1862, made provision for the establishment in the several states of colleges of agriculture and the mechanic arts, and a number of states, from time to time, have extended substantial aid to the cause of technical education. But the one striking and unparalleled fact which stands in the foreground, when we look at the history of technical education in America, is the beneficence and public spirit of private citizens who have established and endowed so many of these splended institutions for the training of American youth.

"Of these, the school established by Stephen Van Rensselaer in 1824 was the first, and it still stands first as measured by the work of its graduates in the broad fields of civil engineering practice.

"But I shall not attempt to discuss what has been accomplished; I prefer to use the time allotted to me to suggest to your minds some of the considerations which make an occasion like the present important not only to those who are peculiarly interested in the welfare and progress of the Rensselaer Polytechnic Institute, but to all American engineers and, indeed, to every patriotic American.



Looking Through Hydraulic Laboratory to Steam Laboratory

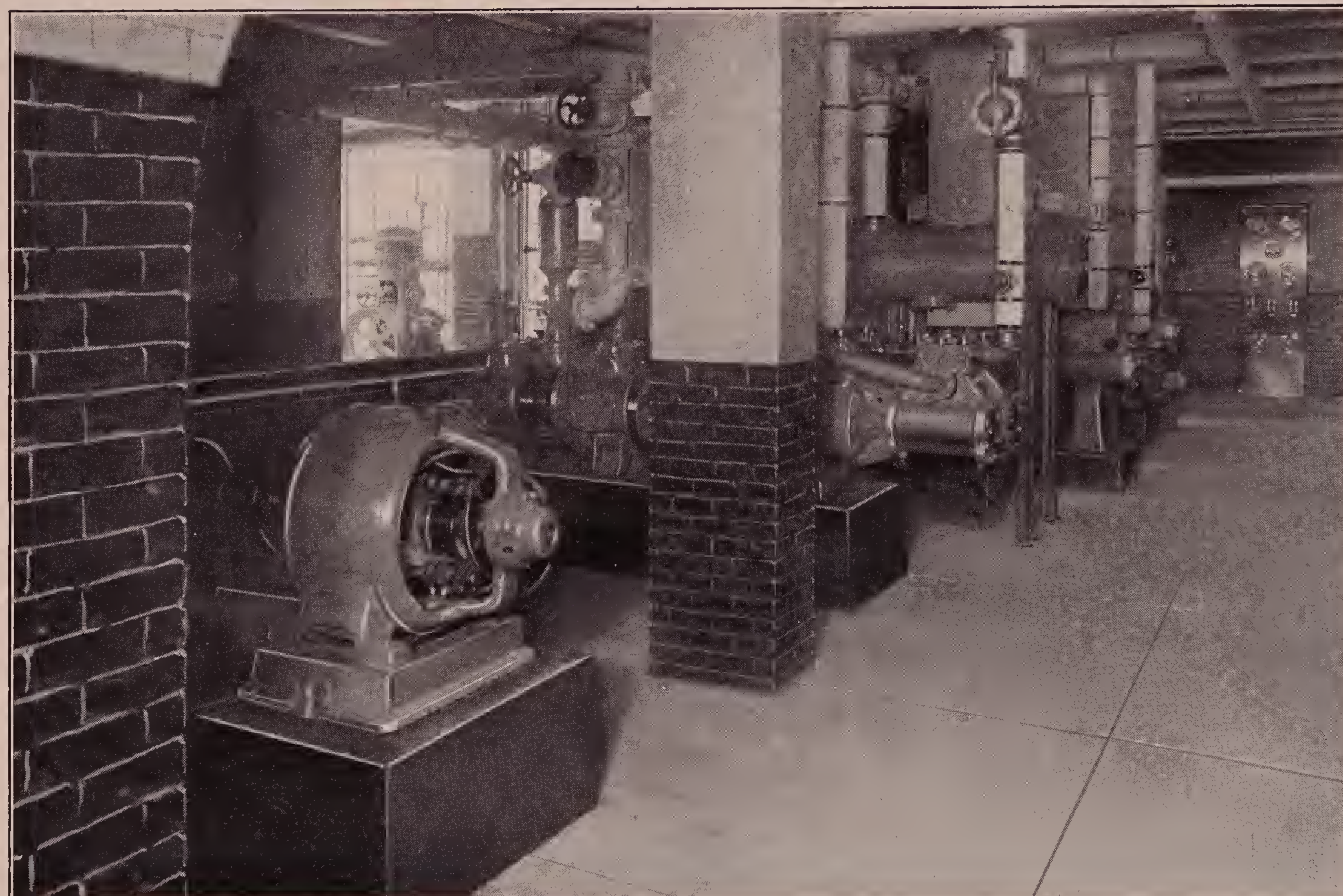
" While the fact that the Rensselaer Polytechnic Institute now possesses in the Russell Sage laboratory a plant whose potential possibilities in the training of successive classes of young engineers are obviously destined to have a far-reaching effect upon the commercial and industrial development of America is the fact which stands out pre-eminently in the foreground to-day, there are other facts which must be sketched into the picture if we are to form anything like a correct and adequate conception of the significance of this event.

" One of these facts has been suggested by what I have already said, viz., that the United States, in all it has to do with science and its practical application, now meets and must continue to meet energetic, able and, in some cases, highly organized and increasing competition.

" Hitherto the vast extent and great natural wealth of the United States, availed of by an energetic and rapidly increasing population, under political and social conditions which, in a degree almost without precedent, have permitted and even invited ' the emergence of the individual,' have resulted in a commercial and industrial development which, as measured, for example, by miles of railroad constructed, by the value of products manufactured or by the quantities of the kindly fruits of the earth produced, has no parallel in history. But quantitative measurements are not the only tests which should be applied to past achievement when we attempt to measure our strength for future progress. Qualitative analysis here is at least equally important. The vast natural resources of a new continent suffice for a time to cover up a multitude of sins of omission and commission by a people which develops and utilizes those resources, but as the primeval forests are cut down or burned and the accumulated fertility of the soil exhausted by use without renewal, the time approaches when those blessed with such a heritage must substitute science, skill and thrift for the hand-to-mouth methods of a frontier community.

" In this process of substitution, beyond question, we have made substantial progress. The work of the agricultural bureau of the United States, the efforts and influence of the graduates of our agricultural colleges and the practical intelligence of our more progressive farmers have increased materially the output per acre of American farms.

" Very recently a beginning has been made in the application of scientific forestry methods to the preservation and renewal of our forests.



Steam Pumps of Hydraulic Laboratory. Switch Board in Distance

" Our mining practice, though still frightfully wasteful of life and material, has improved to some extent in recent years.

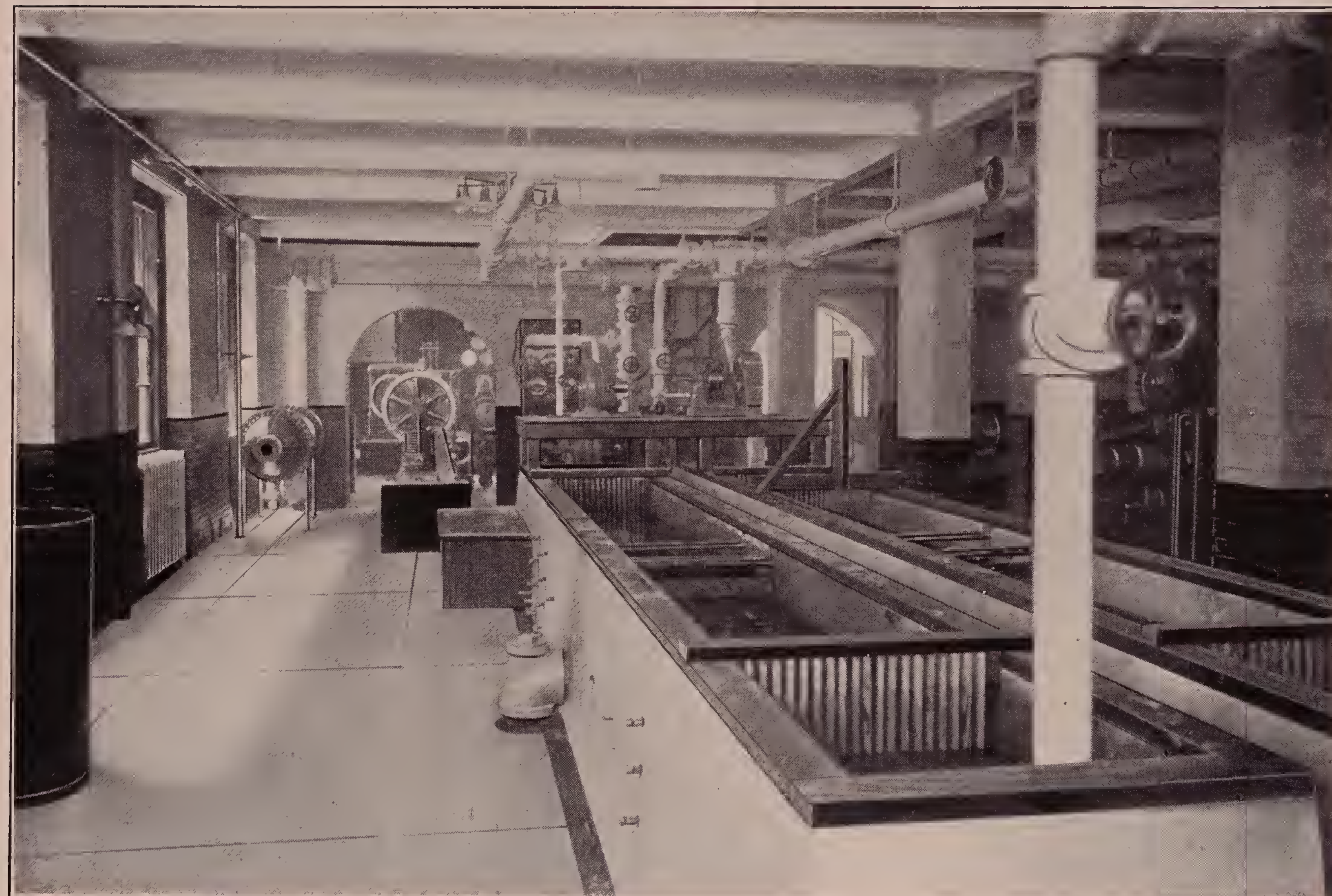
" Our railroad engineers, if their work be compared with the best of foreign practice, have very much to be proud of and comparatively little to explain.

" The practice of our iron and steel mills compares favorably on the whole with that of our great competitors abroad.

" In the textile industries, while our aggregate output is large, we are as yet apparently unable to compete successfully in the production of goods of the higher and more artistic classes.

" Generalization in reference to so comprehensive a subject is always hazardous, but I think it may be said with substantial justice that, broadly speaking, we in America have reached a point where scientific methods and scientifically trained men are needed as they never have been needed before. From now on, industrial and commercial progress must depend more upon refinements of practice and less upon expansion into new fields and to the attainment of such refinements the knowledge and training, which students in this laboratory and in the laboratories of our other technical schools will have opportunity to attain, are factors fundamental and essential.

" Hitherto the construction and equipment of our railroads, the building of bridges, waterworks and docks, the erection, equipment, organization and operation of steel mills, the construction of buildings for all purposes, the development of mines, the design and construction of steam engines, dynamos and the manifold mechanisms of applied mechanical and electrical science have afforded ample sphere for the activities of the graduates of our technical schools. Such apparently will be the case for many years to come, and yet I would point out here the fact that training, such as will be imparted in this laboratory pre-eminently fits men not only to be mechanical and electrical engineers, but also to attack with success the economic and essentially scientific problems which arise in almost every department of manufacturing industry. Decidedly, it is the mental training, the ability to reason accurately from cause to effect, the sense of proportion, which count in preliminary education, rather than the incidental knowledge of facts relating to any particular science or art, and there can be no reason to doubt that, if a few hundred young graduates of the Rensselaer Polytechnic Institute should take up such



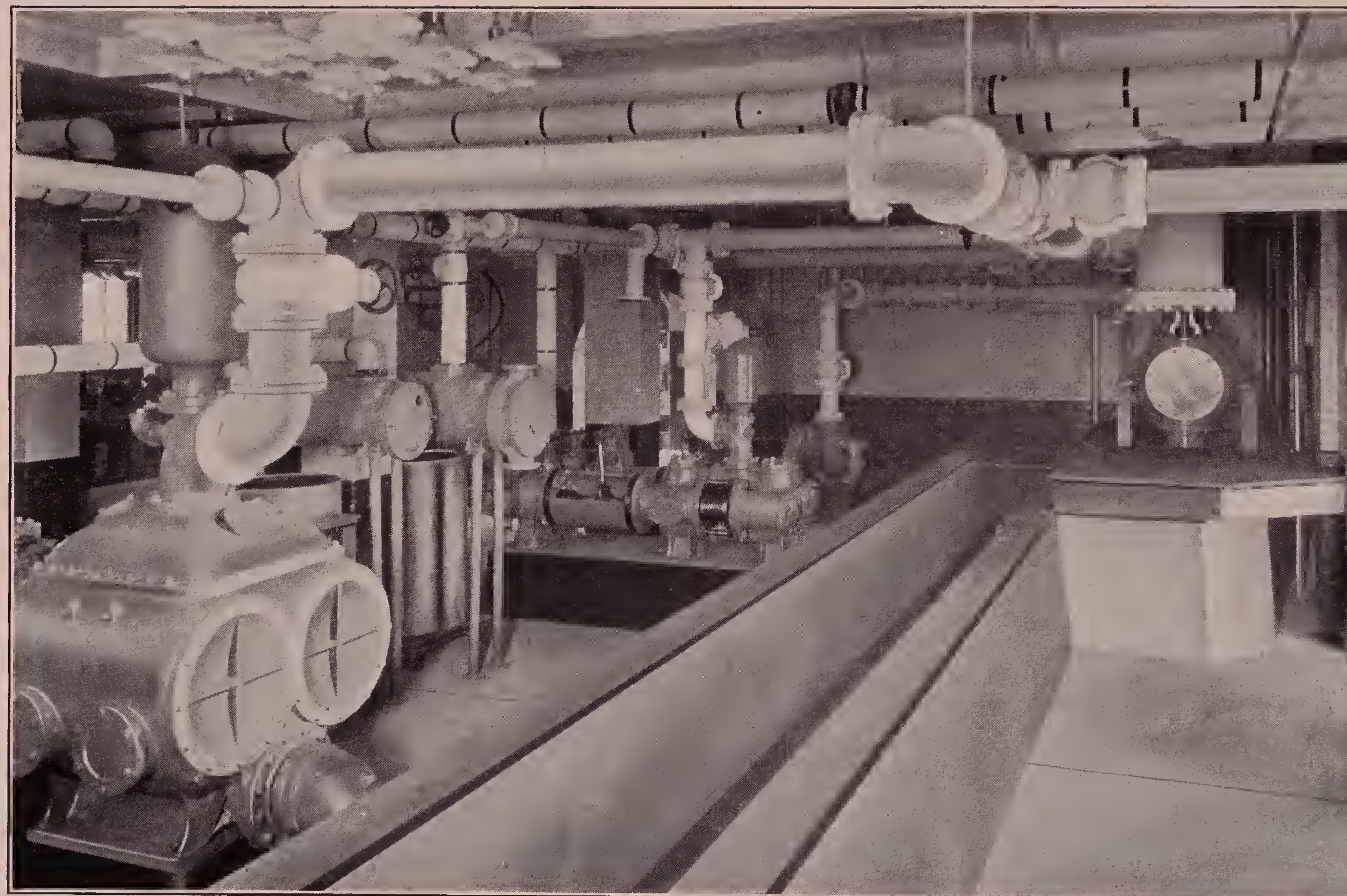
Small Wier Flumes and Water Wheels

work, for example, as that of manufacturing woolen or cotton cloth, the effect of their scientific training would be shown inside of ten years by material improvement in quality and quantity of output and in the economy of production.

"In the electrical field there is constant need of more workers and especially of better trained workers. The value of manufactured products in the United States doubled during the decade from 1895 to 1905. The output of our factories producing electrical machinery and appliances practically doubled in five years. This rate possibly was abnormal, but there is every reason to believe that, for many years to come, the demand for mechanical and electrical equipment will continue to increase at a rate exceeding the average rate of increase for other manufactured products, and consequently the field for trained workers in the practical application of mechanical and electrical science is an expanding one. But the actual field available for graduates of institutions like the Rensselaer Polytechnic is, as I have indicated, much wider even than would be inferred simply from consideration of those spheres of effort which are regarded as peculiarly the province of the engineer, owing to the fact that no other training so well fits a man for success in the many more or less related departments of practical industry.

"But beyond the great value of a mechanical and electrical laboratory such as this, as a school for training students in engineering courses lies another possible, I may even say probable value, viz., the opportunity which it affords and the stimulus which it may be expected to impart to latent talent in the fascinating and wonderful field of original research. The laboratories of the Ecole Normale, where Pasteur learned the A, B, C of chemical science, were ill-lighted, badly ventilated and indifferently equipped. What would Pasteur have thought had he been provided in his student days with facilities such as are here offered? Surely it is not too much to hope that, among the many young men who are destined to work within these walls, some will be found whose preference shall be for pure science rather than for its applications and whose patient research work in later years will result in further additions to the still far from complete basis of scientific knowledge upon which present engineering practice rests.

"The American Institute of Electrical Engineers, which I have the honor to represent upon this occasion, comprises in round numbers 600 members and 6,000 associate mem-



Turbine and Large Flume. Steam and Centrifugal Pumps

bers. Its ranks are filled with graduates of our engineering schools. Much, very much, in the field of practical application has been accomplished, but even within the horizon of our present knowledge we shall need powerful reinforcements from our engineering schools in the immediate future if we are to secure and maintain that relative position in the world of progress which the natural resources of our country, the energy of our people and the opportunities afforded by our institutions demand. And beyond the horizon of our present knowledge what infinite possibilities may await keen and patient research and inventive genius! The Rensselaer Polytechnic Institute is distinguished among our schools of Science and Engineering by the fact that it has never attempted to do more than it has subsequently proved itself able to accomplish with signal success. All who are interested in electrical science must rejoice that this conservatively and ably managed institution, which in the past has done so much to place the American civil engineer in the front rank of progress, is now prepared, under exceptionally competent and earnest direction and with adequate facilities, to add to the army of trained workers in the broad field of electrical engineering.

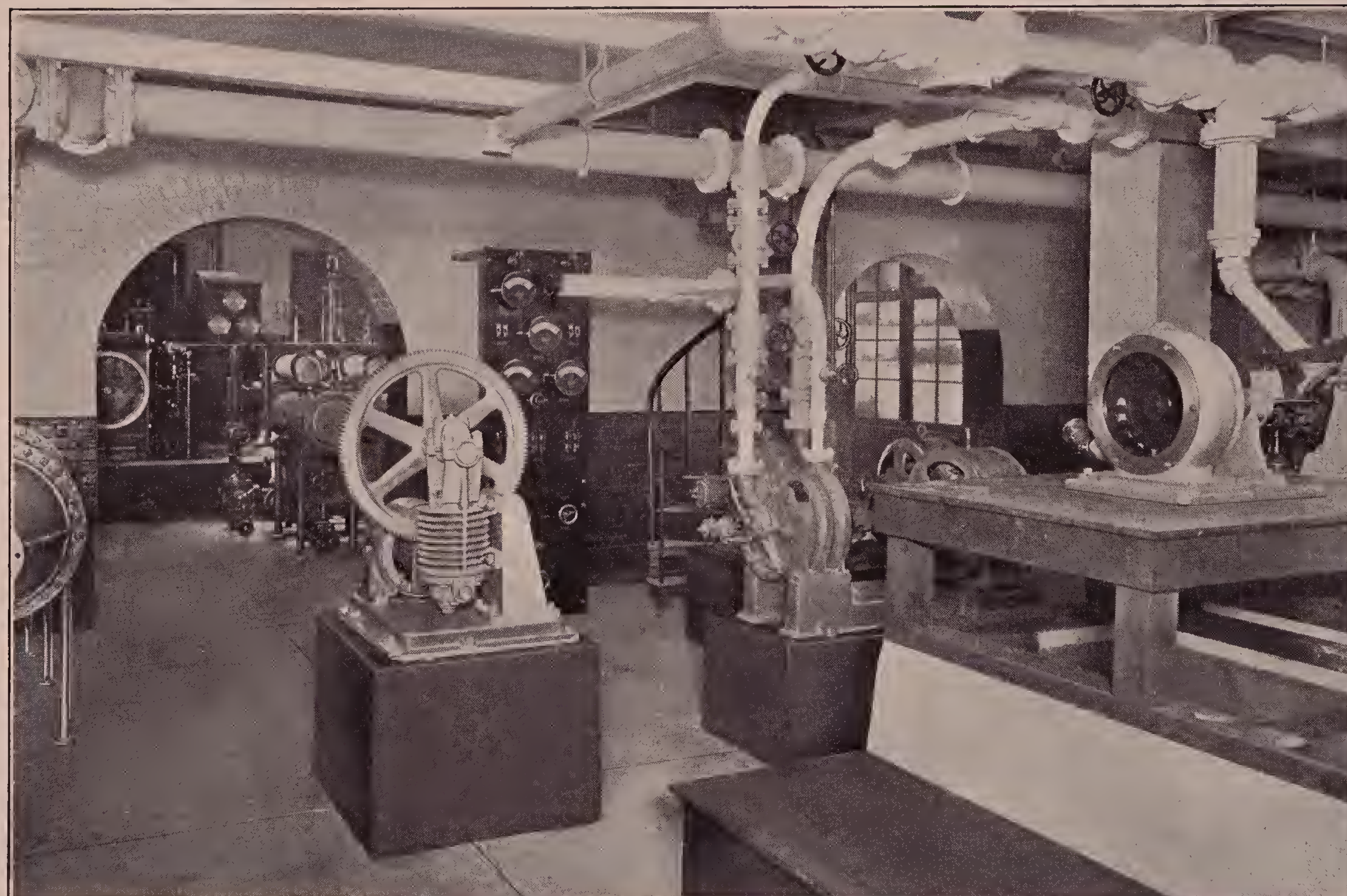
"In behalf of the Institute of Electrical Engineers, I extend hearty congratulations to the Rensselaer Polytechnic Institute upon the acquisition of these splendid laboratories, which are destined beyond doubt to contribute to progress in the arts of civilization to an extent which no one at this time may attempt to measure."

## THE RUSSELL SAGE LABORATORY.

The Russell Sage Laboratory is built of Harvard brick with Indiana limestone trimmings. It is 246 feet long and 80 feet in depth, except the central portion of 50 feet, which is 100 feet in depth. The west wing contains the department of Mechanical Engineering and the east wing the department of Electrical Engineering. The central portion is used by both departments. This portion contains a large lecture room capable of seating over 400 people, a reference library, a museum and a large drawing room. It also contains lockers, wash rooms, janitor's quarters, and the laboratory for the large 600,000 pound machine for testing materials of construction.

### Mechanical Engineering.

The west wing is 100 x 80 feet in plan and five stories in height. In it are the laboratories, class rooms, draughting



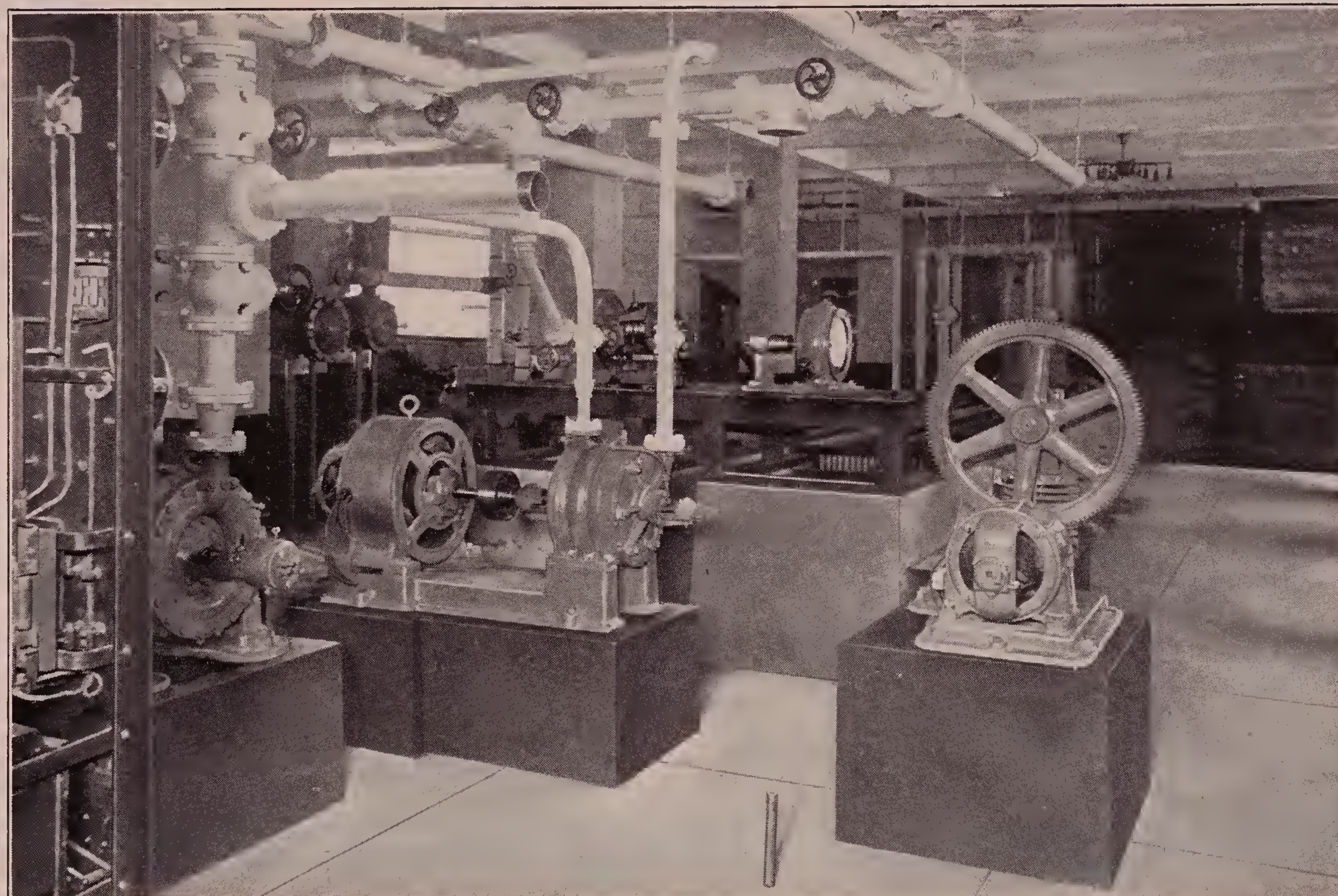
Corliss Engine from Hydraulic Laboratory. Switch Board, Charging Air Compressor, Centrifugal Pump and Water Wheels

rooms and offices of the department of Mechanical Engineering. The laboratories occupy the sub-basement, basement and the larger part of the first floor of this half of the building, while the class rooms and lecture rooms occupy portions of the first, second and third floors. The draughting rooms are in the northwest corner of the second and third floors and the offices are arranged on the different floors for convenience. Lecture rooms, which may be used as recitation rooms, are found on the second and third floors.

**Topic and Lecture Rooms.** — These rooms are intended for recitations during which each man in the class has work at the blackboard. For this reason as much blackboard space as possible is obtained by running a belt of blackboards around the walls of the room at the proper height. The belt is complete, filling all piers or returns at windows. This may be seen from the picture of the typical topic room. When used for this work the sections which recite contain about twenty men and the regular topic rooms are of such a size as to seat that number. Larger rooms are used as lecture or topic rooms. The smaller topic rooms contain plain benches and seat from twenty-four to thirty men, while one larger topic room intended for lectures to small classes will seat thirty-six. The lecture room on the second floor will seat ninety-six men and that on the third floor will accommodate sixty-four.

The furniture consists of benches with tablet arms in those rooms where lectures may be given and plain benches in the topic rooms. The finish of the furniture and wood trim throughout the building is of English oak.

**Draughting Rooms.**— The draughting room on the second floor is intended to accommodate the Senior class and has thirty-six drawing tables, each containing two cabinets, one for each of the two men occupying the table and a common detail drawer between the two cabinets. Each cabinet contains a space sufficient to hold two large drawing boards and a T square, a small drawer for ink bottles and instruments and several shelves for books, papers or drawing materials. The cabinets are of oak while the tops are of white pine with square edges so that they may be used as drawing boards if necessary. The room on the third floor is fitted with forty-eight drawing tables and when fully occupied these two rooms will accommodate 168 men. Each room is provided with a blackboard for instruction purposes and a large filing cabinet for the reception of drawings.



Centrifugal Pumps for High Heads. Water Wheels and Charging Compressor

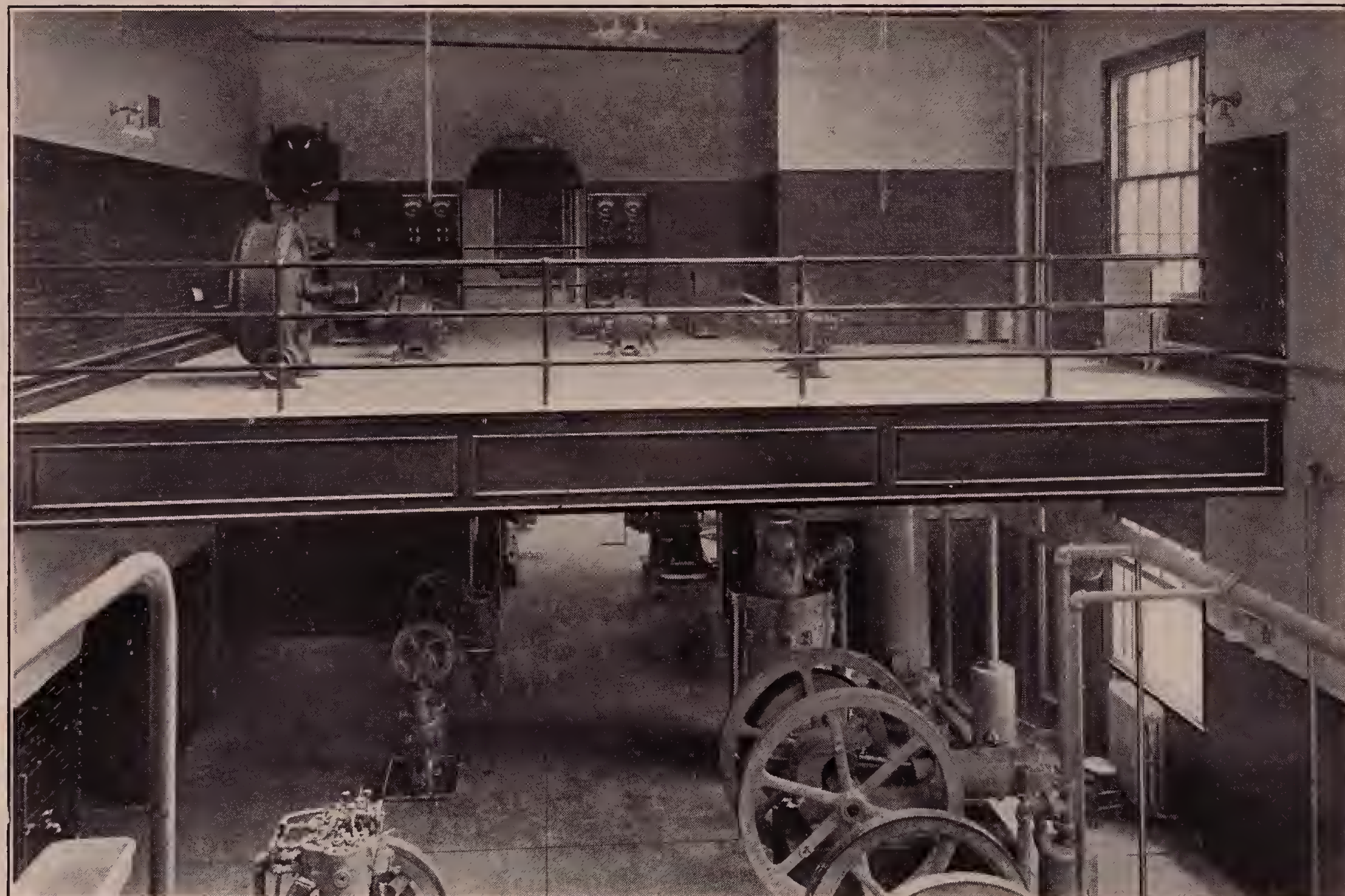
**Laboratories.**— The sub-basement floor contains three laboratories: the steam laboratory, the hydraulic laboratory and the internal combustion engine and refrigeration laboratory. These are all finished in painted rough brick. There is a wainscotting of dark green while the wall above is white. The ceiling is of plaster with smooth white finish.

**Steam Laboratory.**— The steam laboratory covers 2,800 sq. ft. of floor space and contains steam engines, turbines, an air compressor and a superheater. One end of the room is used as a testing floor for the testing of any machines sent to the laboratory for that purpose. The steam supply and exhaust as well as the condensing water supply and discharge are all carried in a tunnel beneath the middle of the room.

The principal engine is an 8 and 18 x 24 Cross Compound Corliss Engine, built by the Wm. A. Harris Steam Engine Co. This engine is arranged with a reheating receiver and the heads of the high pressure cylinder and the heads and barrel of the low pressure cylinder are jacketed. The cranks are so arranged that the angular position of the pins may be changed and the strokes may be altered by changing the radius of the crank in selecting other holes in the crank discs. In this way the cylinder ratios may be varied from 1:7 to 1:3. The clearance is equalized on the ends in these changes by fastening filling pieces to the piston. The high pressure cylinder is special in that the steam chest is separated into two parts by a cross partition so that steam is admitted to each through a separate throttle valve. The exhaust chest is arranged in the same manner and separate exhaust pipes lead from each end to separate condensers. In this way when the high pressure cylinder is used alone it will be possible to find the amount of steam on each end of the cylinder, thus determining how the steam supply divides between the two ends, the quality at cut off on each end and the effect of the piston rod. The steam leakage around the piston may be found by cutting off the steam supply on one end and determining the condensation on that end.

The two exhaust pipes may discharge together into the receiver from which the steam passes into the low pressure cylinder or when necessary the high pressure steam may be cut off and the low pressure cylinder worked from live steam taken through a reducing pressure valve.

The condensers attached to this engine are Worthington surface condensers equipped with wet discharge pumps at the bottom of each condenser and a dry air pump common



Fan Room. Gas Engines. Hot Air Engines

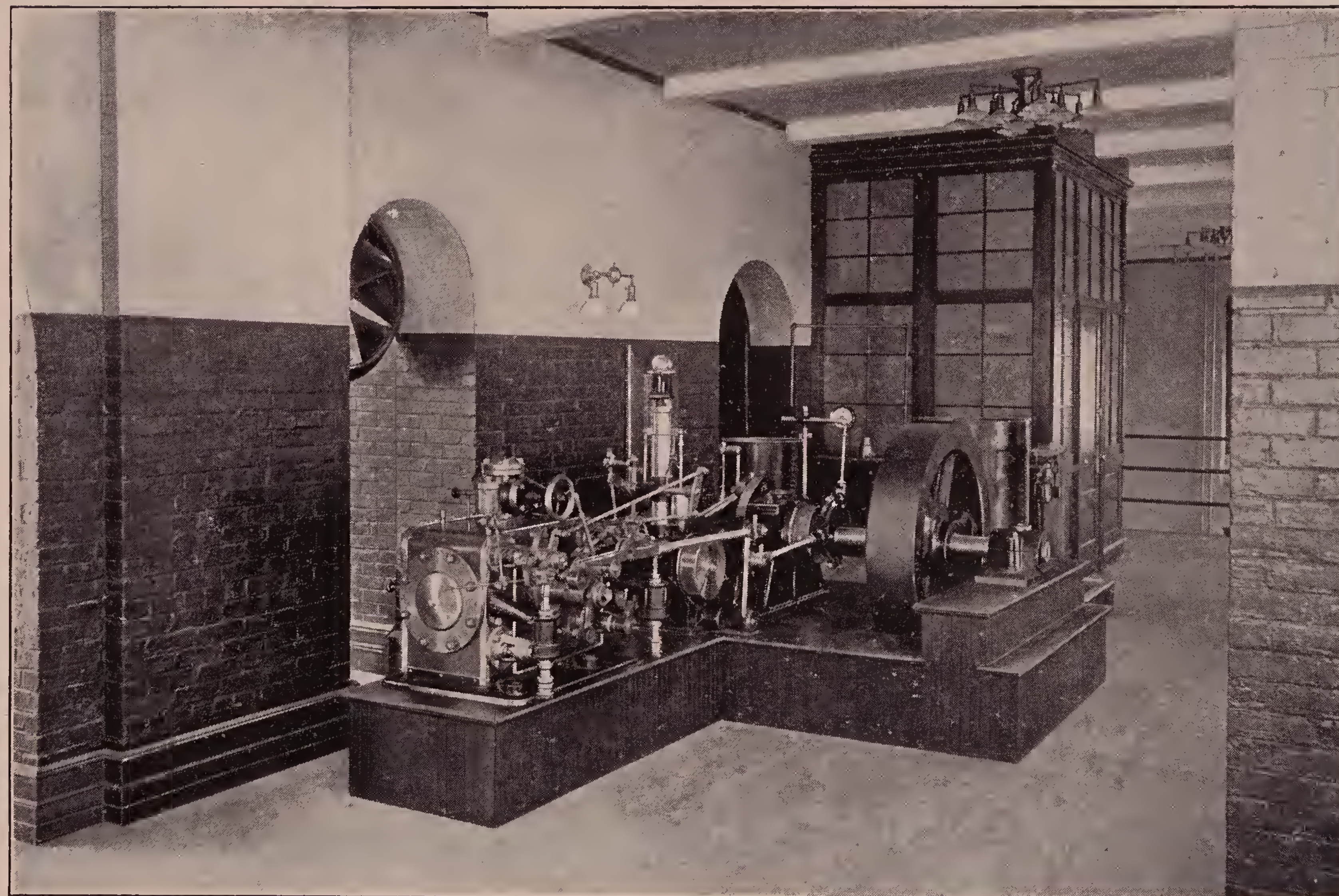
to the two condensers. This equipment is designed to give a very low vacuum.

The 10, $16\frac{1}{4}$ and $10\frac{1}{4}$ x 10-inch air compressor built by the Ingersoll-Rand Co. is placed next. It is of the two stage compression type with two single expansion steam cylinders in tandem with the air cylinders which are cross-connected through an intercooler. The steam cylinders are equipped with Meyer valves and the air cylinders are equipped with piston inlet valves of late design. The discharge from the compressor is carried into one of two large tanks through a safety valve and three-way cock. The discharge from the compressor is to be kept at constant pressure as the pressure in the tank increases to the compressor pressure. When this is obtained the air is shifted to the other of the two tanks and from the pressure, volume and temperature of the first tank the amount of free air compressed may be determined and then the air in this tank is discharged into the room. The steam consumption of the compressor engine is determined by means of a non-vacuum condenser built by the C. H. Wheeler Co.

The high speed engines are represented by a $5\frac{1}{2}$ x 10 Buckeye engine, a $6\frac{1}{4}$ x $10\frac{1}{2}$ x $6\frac{1}{4}$ vertical Cross Compound engine built by B. F. Sturtevant, a 7 x 7 McEwan engine, and a 6 x 8 Buffalo Forge engine. These engines are all of recent construction and each is connected to its own condenser. The Buffalo Forge engine is connected to a C. H. Wheeler non-vacuum condenser, the McEwan to a Platt Iron Works condenser with a combined air and circulating pump, the Sturtevant to a C. H. Wheeler condenser connected to a Mullen Valveless air pump and the Buckeye to a Worthington condenser with a combined air and circulating pump.

The turbine equipment consists of a 10 H. P. DeLaval turbine, a 10 H. P. Sturtevant turbine and a 20 H. P. Kerr turbine. These turbines are so arranged that any one of them may exhaust into the air, a C. H. Wheeler non-vacuum condenser or a Wheeler Manufacturing Co. condenser equipped with an Edwards air pump. The steam supply may be saturated or it may be taken from a portable Foster superheater capable of heating 600 pounds of steam per hour to 765° F.

The testing floor consists of Z bars mounted on concrete piers and so fixed that machines of various forms may be readily set up. Steam and exhaust piping, compressed air and electric power leads are placed near here so that a



Corliss Engine for Valve Setting. Water Meter. Testing Tank. Instrument Room

supply of various forms of power can be had for testing machines of all kinds.

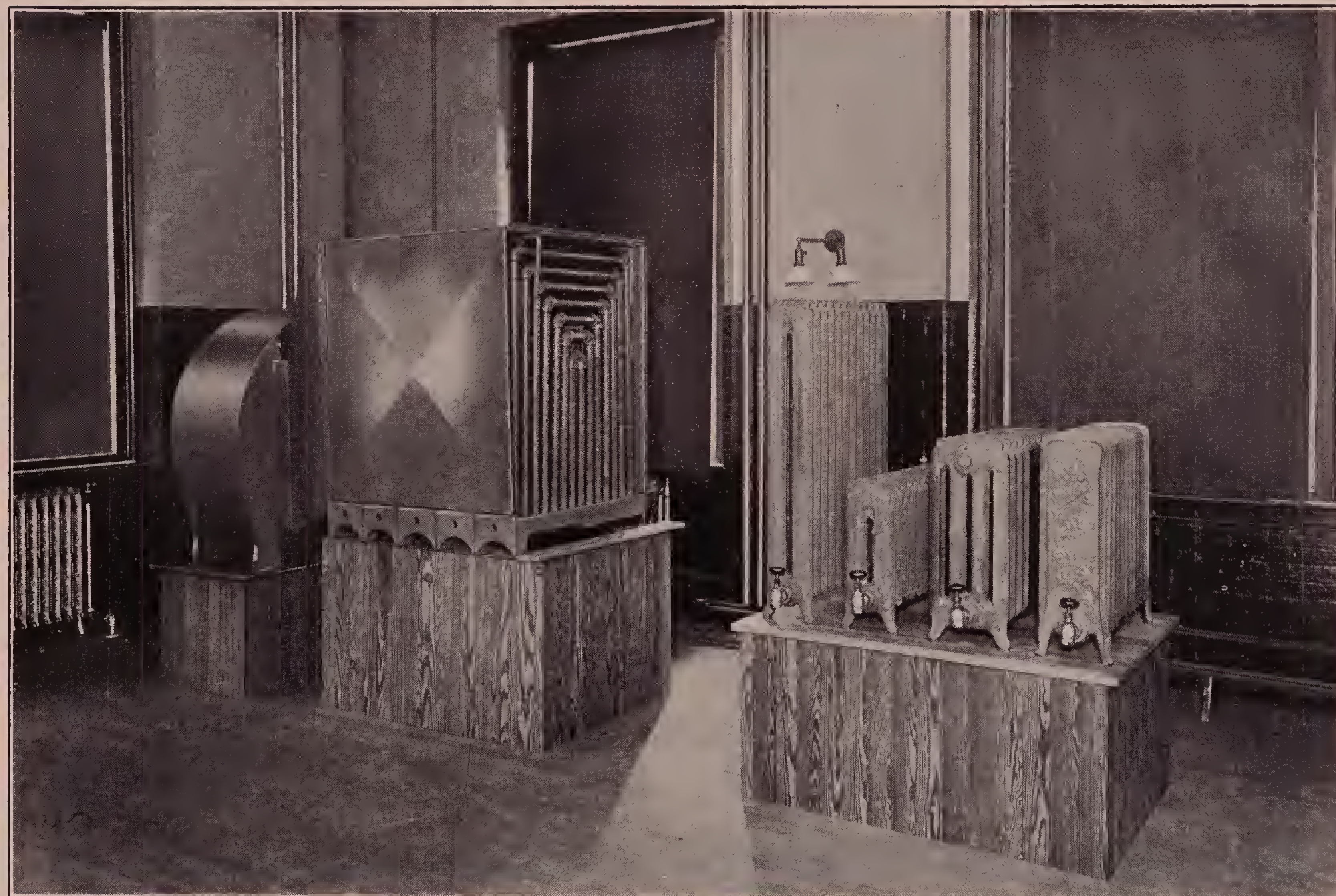
A four ton Maris Bros. hand crane running the length of the room is used in erecting or repair work while a one ton Dale portable crane is of service under the gallery.

The cooling water from the condensers is taken to a spraying fountain on the low roof of the boiler house for cooling after which it returns to the cistern beneath the hydraulic laboratory.

It is to be noted that different types of surface condensers and air pumps are represented in the equipment of the laboratory.

**The Hydraulic Laboratory.**—The Hydraulic Laboratory contains pumps, water wheels, turbines and apparatus for determining the losses in the conveyance of water as well as for the measurement of large quantities of water. It covers 2,500 square feet. The steam pumps are placed along the main aisle. A tandem steam duplex pump of Worthington make is used for duty tests and to supply water under 300 ft. head. It is an 8 x 12 x 7 x 10 outside packed plunger pump of the water-works pattern and is supplied with a pump governor so that the pressure may be controlled at any desired head between 100 and 300 feet. The 10 x 10 x 12 low pressure duplex tank pump of Fairbanks, Morse & Co. will handle 1,000 gallons per minute. These pumps are provided with non-vacuum surface condensers for the purpose of determining steam consumption. A 12 x 6 x 12 Marsh steam pump is used as an example of a simplex pump while a small pulsometer and a Sellers, Class N, Injector are used for testing the direct application of steam to the raising of water. A Dean triplex pump and a Root rotary pump represent the power pumps. These are driven by electric motors as is the case with the centrifugal pumps. The motors are controlled from switch boards at convenient places. These boards are furnished with ammeters for each motor and a common voltmeter so that the power taken to drive each machine may be determined. There are three centrifugal pumps: a single stage Lawrence pump of 1,000 gallons capacity, a two stage Platt pump for an 80-foot head and a three stage Worthington pump for a 250-foot head.

A 12-inch Doble water wheel and a 12-inch Pelton wheel represent the simpler types of impulse turbines while an Escher, Wyss & Co. wheel with a high grade governor represents the European development of this type of high head wheel. These wheels receive water from the



Heating and Ventilating Laboratory

Worthington duplex pump or from the high head centrifugal pump after passing the water through a large air tank to equalize the pressure. The air tanks are charged by a small motor-driven air compressor. A 10-inch Leffel turbine is installed over the long flume for turbine investigation. This turbine takes its supply from a 25,000 gallon tank on the floor above under a total head of about twenty feet. The discharge from this and the other apparatus is cared for by a cistern of 25,000 gallons capacity, placed under the floor. Most of the pumps draw from this cistern and by properly connecting the pumps 3,000 gallons a minute, under a head of 20 feet, is available for testing water wheels.

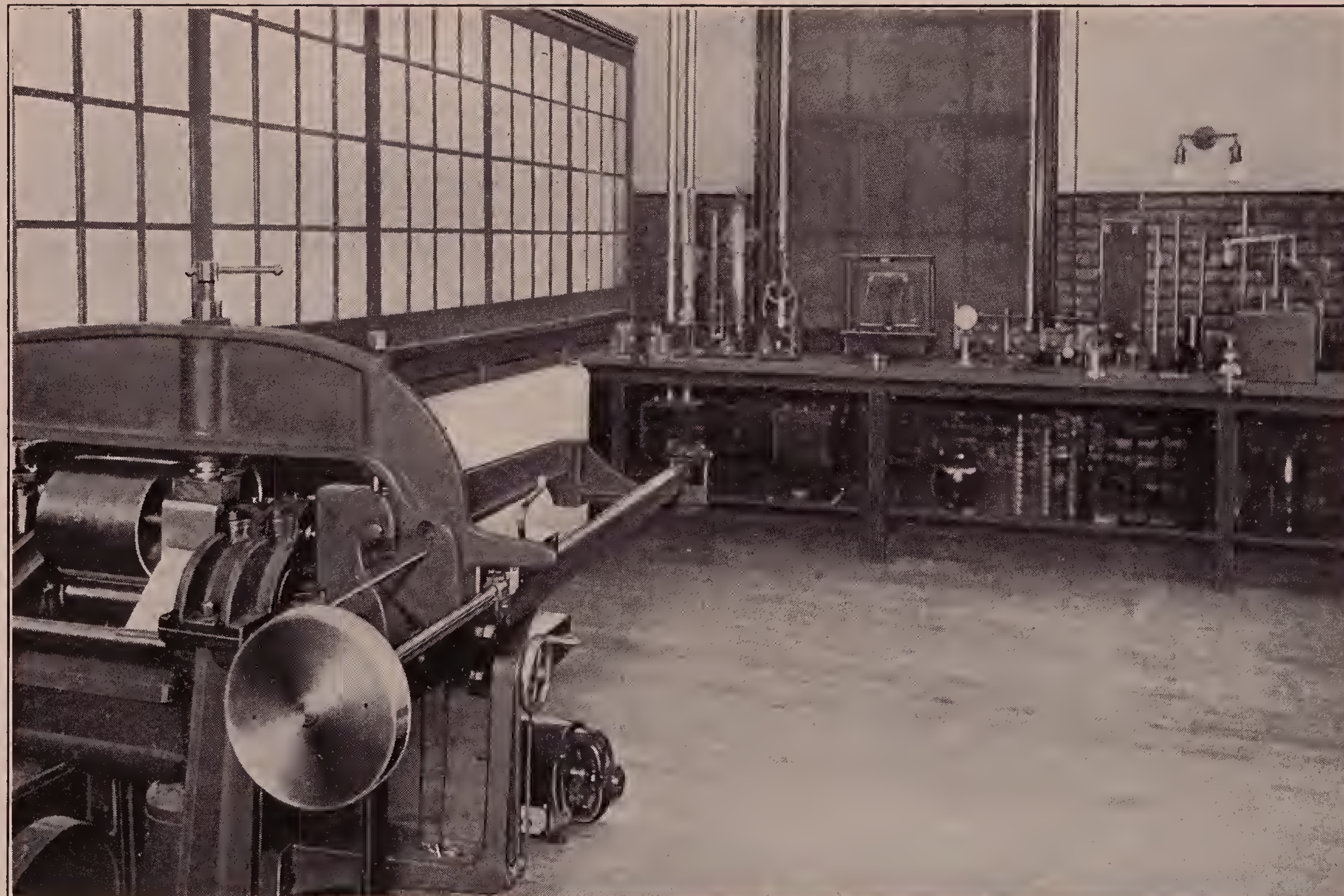
The discharge from the water wheels, turbines or pumps is measured by flumes, of which there are five, or by Venturi meters, and provision is made for determining quantities by Pitot tubes, calibrated nozzles, floats, current meters, and aprons. The long flume is used for channel experiments. All flumes are provided with permanent measuring tubes for investigations of changes in head and velocity along and across channels. The flumes are of concrete construction.

Provision is made for investigations of friction in pipes, bends, valves and other obstructions and the determination of co-efficients used in hydraulic work.

The calibration of water meters, and the experimental work with the hydraulic ram and injector, will be performed on the basement floor where other space is available for this work.

**Internal Combustion Engine and Refrigeration Laboratory.**—This laboratory covers 1,600 square feet of floor space and is equipped with gas, gasoline, alcohol and oil engines, hot air engines and an ammonia compressor. The machines are arranged in two rows. In one of them are a 12 H. P. Otto gas engine directly connected to a small suction gas producer, a 12 H. P. Fairbanks-Morse engine for illuminating gas, gasoline or alcohol, a 2½ H. P. Meitz & Weiss kerosene engine, and a 10 H. P. Du Bois engine for gasoline or gas, while in the other row are the 3-ton steam-driven Frick ammonia compressor, a 6 H. P. Secor oil engine of the Marine Engine & Machine Co., a 6 x 8 two-cylinder Westinghouse gas engine, a Rider Ericsson hot air engine and an Ericsson hot air engine. These may be seen in the two illustrations of this room.

**Refrigerating Plant.**—This plant contains two receivers arranged to weigh the amonia, a double pipe ammonia



A Corner of the Oil, Gas and Fuel Laboratory

condenser, a triple pipe brine cooler, two refrigerating rooms and a brine tank for ice making. The rooms may by cooled by brine or by direct expansion and they are separated by a portable partition which may be made of different materials for investigations in insulation. All coils are arranged to receive pressure gauges and thermometers at inlet and outlet so as to determine the change in pressure or temperature in the coil. The rooms are built of concrete and Nonpareil compressed cork. It is arranged for great insulating capacity.

The basement floor contains the fan room, the valve setting laboratory, the space for water meter testing, the transmission laboratory, the generating plant, the space for testing injectors and the hydraulic ram as well as the repair shop for the department.

The fan room, of 700 square feet, contains the following fans and blowers: a two stage blower, a No. 6 pressure blower and a 30-inch volume blower made by the Buffalo Forge Company, a 34-inch Sirroco blower, a 30-inch Sturtevant ventilating fan and a No $\frac{1}{4}$ Root blower. These are all driven by motors so arranged that the power input may be determined. The space reserved for valve setting contains 500 square feet and is equipped with a Murray Corliss engine and a Sturtevant D slide valve engine. These are arranged for valve setting by measurement; and by the indicator in which case compressed air is employed.

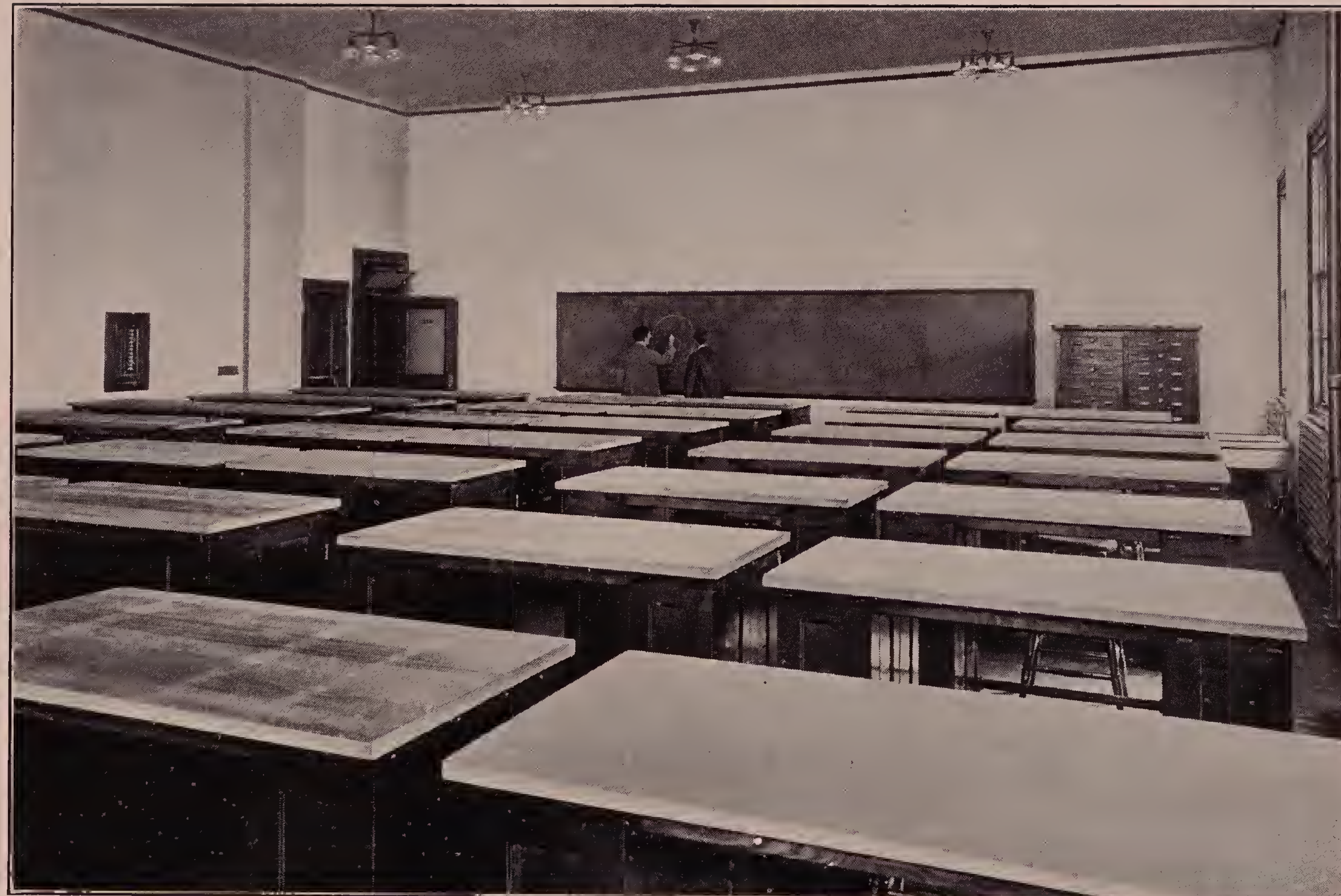
The water meter testing is done by actually measuring the discharge of water from small meters. A low tank, containing the weighing tank and scales, is placed next to the Murray engine for this purpose.

The transmission laboratory is equipped with apparatus for testing belt and rope transmission as well as the efficiency of various forms of gearing. It has 800 square feet of floor space.

The generating plant consists of a motor generator built for the transformation of A. C. current into direct current for use in the variable speed motors. The switch-board panels at this point control the various circuits for the west half of the building.

The repair shop is used for the apparatus installed or for the construction of new apparatus. It is equipped with lathe, shaper and milling machine.

**Instrument Rooms.**—Those instruments, not attached to the apparatus on the sub-basement and basement floors, are kept in the small instrument rooms shown on these floors in the picture of the Steam Laboratory. These rooms are



Junior Drawing Room

equipped with shelves, drawers and lockers for the reception of instruments and these are divided so that all the apparatus for one machine is found together.

**Small Laboratories.**— About 3,500 square feet of floor space is divided into small laboratories. One of these is devoted to hoisting apparatus; another to heating and ventilation; another to tachometers, anemometers and such apparatus; another to oil, gases and fuels; one to gauges, indicators and thermometers; one to standards, and two are intended to be used for special work.

The hoisting room contains various commercial hoists and jacks so arranged that the efficiencies may be determined and a study made of their construction and operation.

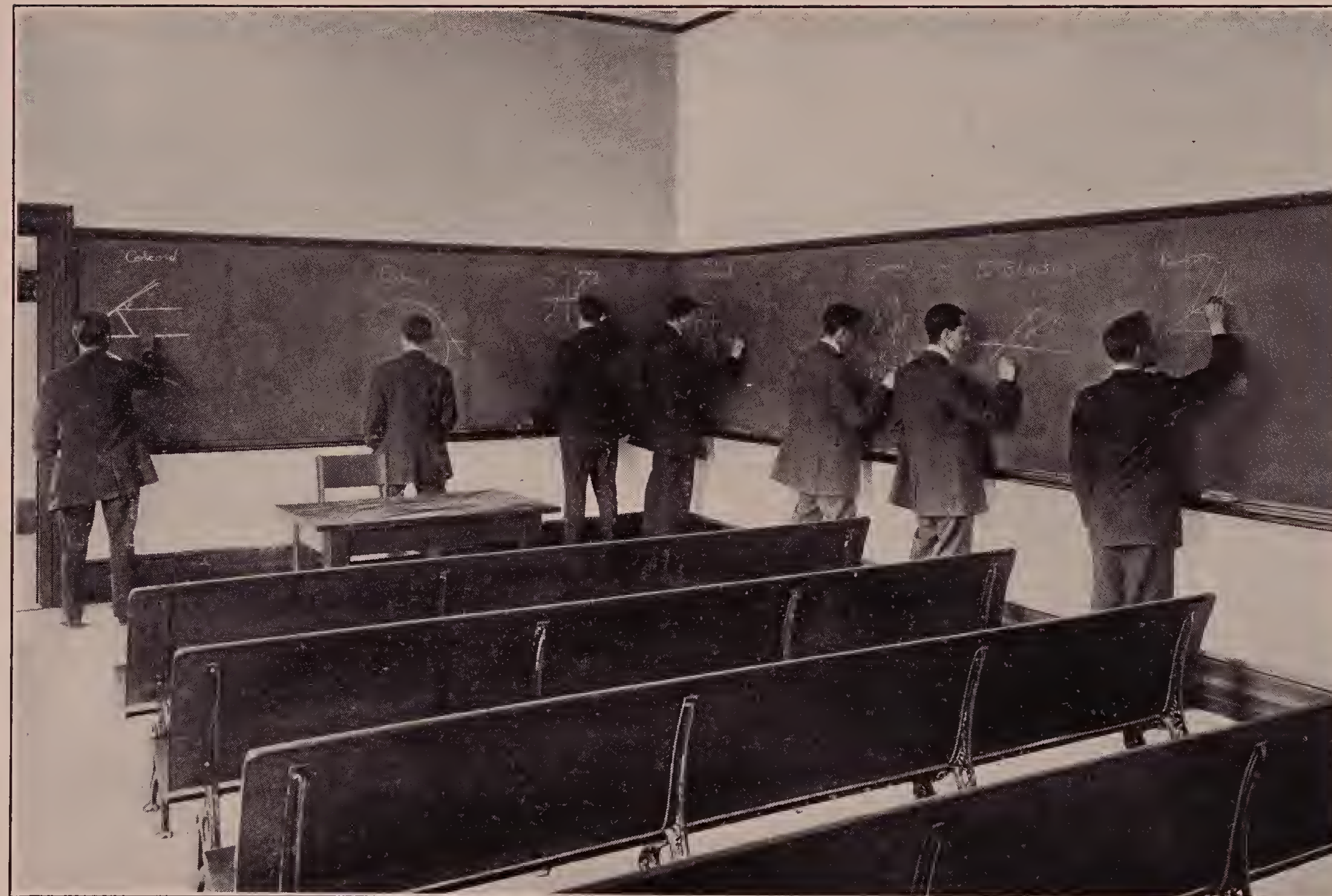
The heating and ventilating laboratory is equipped with various forms of radiators for direct heating and a pipe coil and fan blower for a study of indirect methods of heating. The apparatus is so arranged that the heat used in the various coils or radiators may be determined simply and accurately. The power used for ventilation is determined from the motor by means of ammeters. For testing pipe covering, a special arrangement of pipes and drip pots is employed.

The laboratory for the testing of anemometers and tachometers is equipped with special apparatus for this purpose, each machine being driven by a variable speed motor. By means of electro magnets the recording parts of the apparatus are thrown into gear simultaneously thus giving accurate readings.

The oil, gas and fuel room is equipped with an Olsen oil testing machine; chill point and flash point apparatus of new make; viscosimeters; balances; the Elliot, Hempel and Orsat forms of gas apparatus, gas meters, Junker calorimeter for gas and oil; Mahler Bomb calorimeter; Parr Coal calorimeter; apparatus for coal analysis; drying ovens and other apparatus for the treatment of oils, gases and fuels.

The gauge, indicator and thermometer room is equipped with a manifold for testing indicators, a weight guage tester, a mercury vacuum tester, hypsometers, and ice pails as well as a set of thermometer wells for the determination of errors in thermometers at high temperatures.

The standard room contains the higher grade instruments for use in the laboratories or for comparison. A Wanner Pyrometer, two thermo couples with a recording voltmeter and a simple voltmeter, a Siemens water pyrometer and



A Typical Recitation Room

several high grade thermometers serve to measure temperature while several Beckman thermometers are to be used to measure small changes in temperature. For measurement of length two standard meters, a comparator and a cathetometer are used. A high grade barometer, a standard pound, two high grade scales, and a high grade clock are employed for accurate work or for the calibration of other instruments. The room contains voltmeters, ammeters recording drums, indicators, a manograph, planimeters, stop watches, laboratory stands, hydrometers, hygrometers, spherometers and other apparatus for careful work.

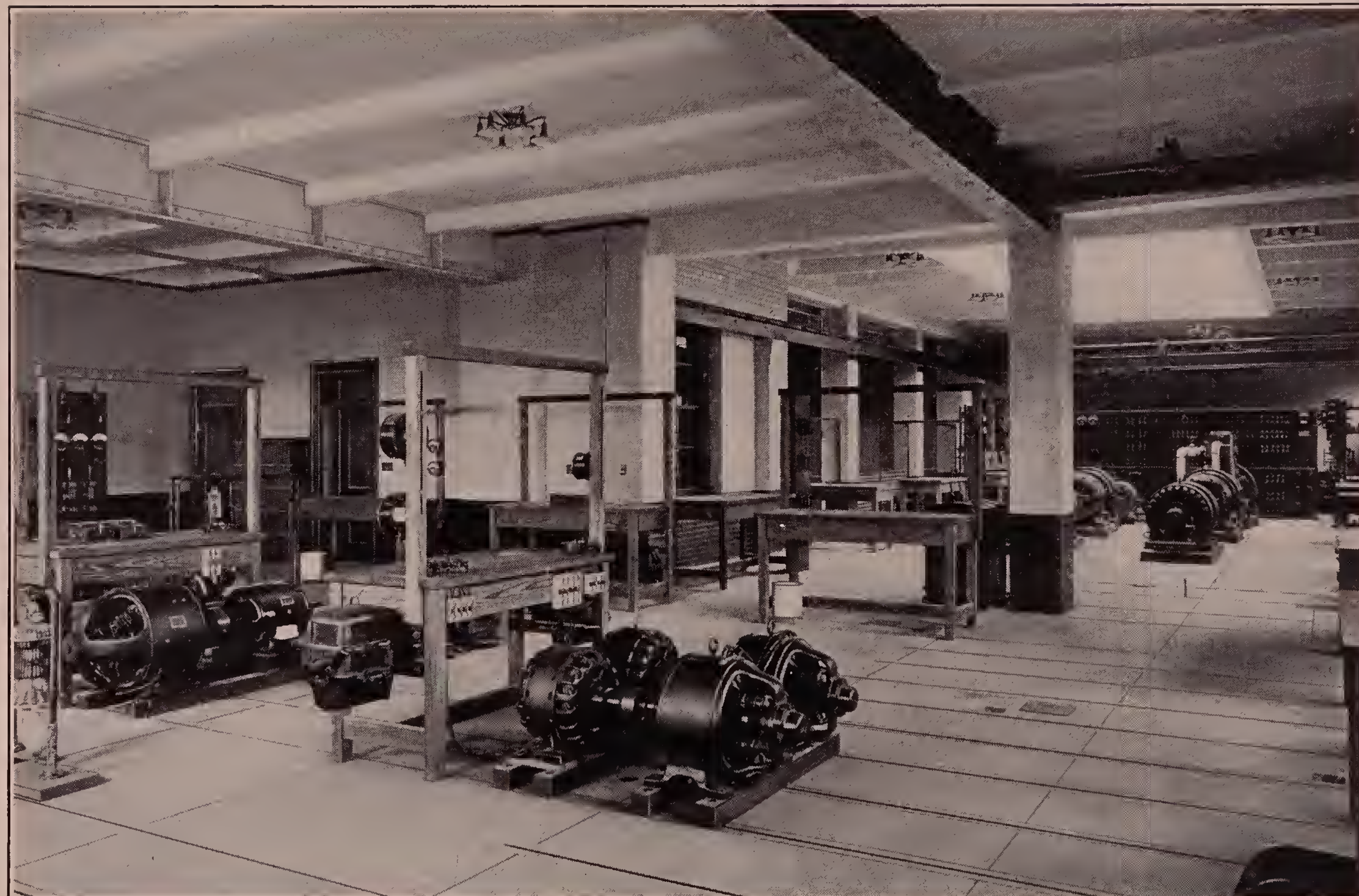
The two rooms for special work are equipped with laboratory tables, drawing board, running water, gas and electric current of A. C. and D. C. form.

## Electrical Engineering.

The east wing is 100 feet by 80 feet in plan and four stories in height. The basement of this wing contains the generating plant, dynamo laboratory, storage battery and transformer rooms, the electro chemical laboratory, rooms for blue printing and photographic work and the instrument shop.

**Electrical Laboratory.** — The Electrical Laboratory obtains both direct and alternating current from the mains of the Troy Electric Light Company, a total of 150 kilowatts being available from this source. The alternating current is supplied at 2,400 volts, two phase, 40 cycles and is transformed to 220 volts by six subway type transformers. The transformers are located in a room adjoining the generating plant and are controlled from the main switchboard by remote control switches with overload relays and a constant voltage is maintained by means of induction regulators. The direct current is supplied at 550 volts.

**Generator Plant.** — The generator plant is equipped with two 25 K. W. 110 volt direct connected generators, one of which is driven by a cross compound marine type engine and the other by a Curtis steam turbine. In addition to these generators there are two 25 K. W. synchronous motor driven 110 volt generators for supplying direct current, two 25 K. W. motor generator sets supplying 3 phase current, one at 60 cycles and the other at 25 cycles, a 15 K. W. induction motor driven exciter set with Tirrill regulator, a 25 K. W. three unit set consisting of an induction motor connected to two low voltage D. C. generators supplying for electrolytic and



General View of the Electrical Engineering Laboratory

standardization purposes 3,000 amperes at 8 volts or 1,500 amperes at 16 volts, and a 30 ampere mercury arc rectifier.

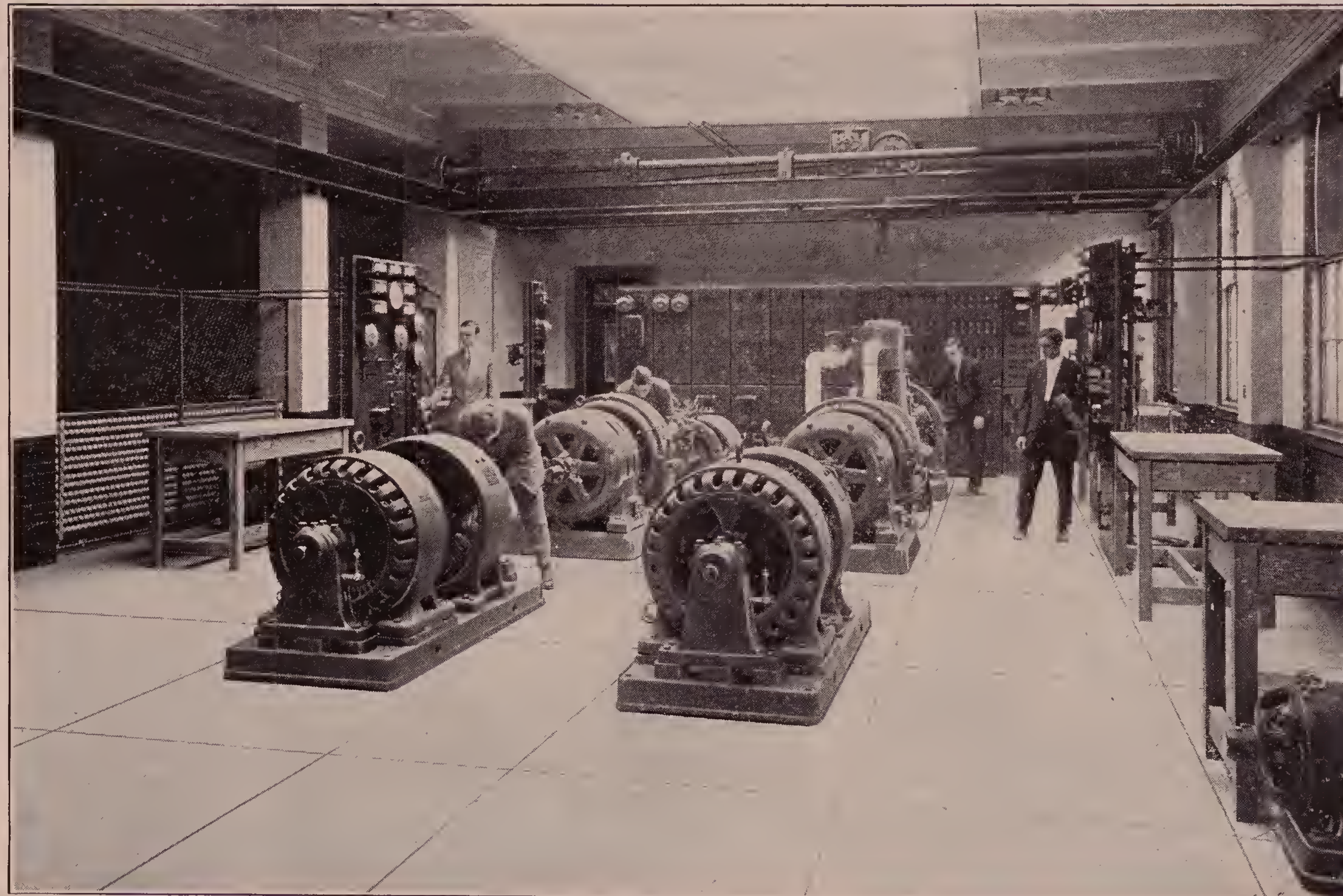
The main switchboard for the control of all circuits in the Sage Laboratory and the other buildings of the Institute is located in the generator room. The equipment of this room includes a two ton, three motor electric traveling crane with floor control.

**Battery Room.**— The battery room is equipped with 66 cells, each of 120 ampere hours' capacity and four cells, each of 4,000 ampere hours' capacity. The cells have chloride negatives and Manchester type positives. The battery is especially useful in connection with photometric work and the standardization of instruments.

**Electro-Chemistry.**— Three rooms are devoted to the work in electro-chemistry.

The equipment includes a 50 K. W. Heroult furnace and a 10 K. W. induction furnace of the Colby-Kjellin type for experimental work in the refining of steel and the manufacture of high melting alloys, an experimental Arsem furnace for research work in vacuum and an Acheson furnace with water cooled electrodes for the manufacture of graphite, titanium carbide, etc. The generating plant is equipped to supply any of the standard forms of electrical energy to illustrate the various technical processes for the reduction of metals such as copper, aluminum, lead, by electro-chemical means. All facilities in the nature of carbon and graphite electrodes and refractory material such as fireclay, silica, magnesia, alumina, and chromate brick are at hand to aid in the building of furnaces for manufacturing various electro-chemical products such as the ferro-alloys and calcium carbide.

**Dynamo Room.**— The dynamo room is devoted to the testing of generators and motors. The floor construction is such that machines can be quickly set up and adjusted; a two-ton hand power crane is available. The machines are of a great variety and include one Edison 3 K. W. 110 volt D. C. generator, one Western Electric 5 K. W. D. C. generator, two 6 K. W. Allis Chalmers D. C. generators, one Crocker Wheeler dynamotor for electrolytic work, one General Electric 7.5 K. W. 3 phase alternator, one General Electric 7.5 K. W. 2 phase alternator with motor driven exciter, and two 10 K. W. Westinghouse 550 volt rotary converters. The motors include, in addition to several small motors, an electric railway motor testing set consisting



Main Switch Board. Generator Sets. Motor Generators and Frequency Changers

of two 25 H. P. 550 volt motors mounted on an interurban truck, with friction wheels, fly wheels, water brakes and traction dynamometer, air and hand brakes and a full equipment of instruments for a complete series of tests; two Westinghouse 10 H. P. type K induction motors, one General Electric 7.5 H. P. type L induction motor, one General Electric 3 H. P. single phase induction motor, one Lincoln 7.5 H. P. variable speed motor, one Electrodynamic Company's interpole variable speed motor, one Westinghouse 7.5 H. P. 110 volt compound wound motor, one General Electric 5 H. P. series motor.

The laboratory is equipped with all the necessary voltmeters, ammeters, wattmeters, frequency indicators, tachometers, Prony brakes, etc., for carrying on tests on all the machines at the same time.

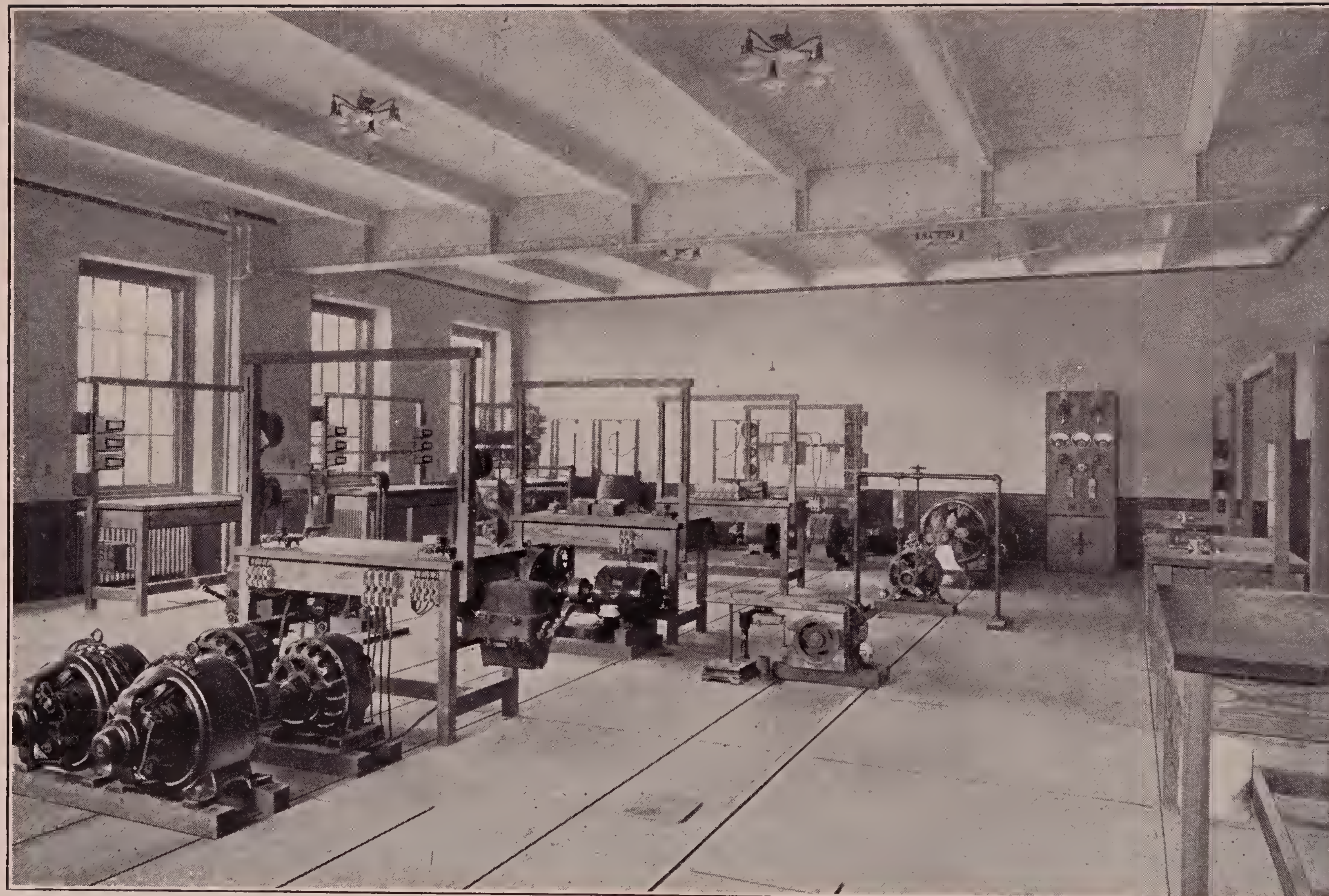
**Instrument Shop.**—The instrument shop is used for the repair and construction of apparatus. The equipment includes a 14-inch Hendey lathe, a 15-inch Potter and Johnson shaper, a Dwight slate sensitive drill, a Northern Electric buffer, a gas-forge and one ton overhead traveling crane. All the tools are motor-driven.

**Blue Print Room.**— The blue print room is arranged for blue printing by electric light.

**First Floor Rooms.**—The first floor of the east wing contains two lecture rooms, two topic recitation rooms and the executive offices of the Department of Electrical Engineering.

**Electrical Measurements.**— The second floor contains the laboratory for electrical measurements, a smaller laboratory for studying the phenomena of high tension and alternating currents, a room for the study of wave forms and other alternating current phenomena, including phase relations, field discharge, resonance and initial conditions in circuits and cables, and a large room for the calibration, standardization and testing of instruments, apparatus and materials used in Electrical Engineering. Beside these there are two rooms devoted to research work. The laboratories are equipped with the necessary ballistic and aperiodic galvanometers, bridges, standard cells, condensers, resistance coils, induction coils, ammeters, voltmeters, wattmeters, etc., so that all the determinations included in a course can be undertaken at the same time.

The equipment includes various types of Wheatstone bridges, galvanometers, condensers, a complete set of Reichsanstalt standard resistances, a Du Bois magnetic



Generators and Motors

balance, conductivity bridges, cable testing sets, potentiometers, and standards of self-induction.

**High Tension Room.**— The equipment of the high tension room comprises two General Electric 5 K. W. 2,200 volt static transformers, one General Electric constant current floating coil transformer, with equipment of lamps, two Westinghouse 1 K. W. 2,200 volt static transformers and two Westinghouse 10 K. W. 10,000 volt transformers. The equipment also includes induction coils and other necessary apparatus for experiments in wireless telegraphy and x-rays.

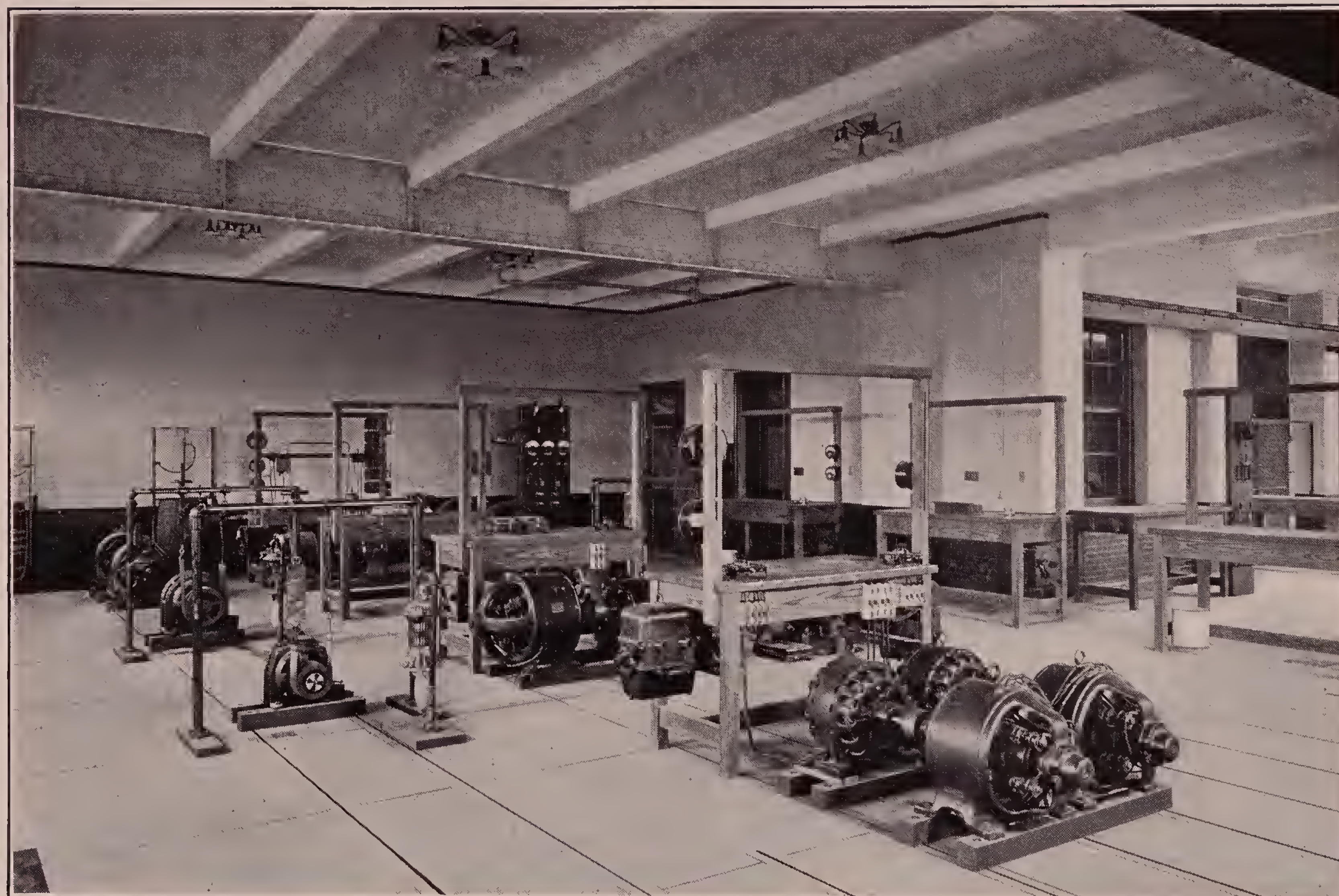
**Physical Laboratory.**— On the third floor is found the large laboratory devoted to general physics, heat and sound, while adjoining is the room devoted to the study of light. This room is so connected to the adjoining rooms, devoted to photometric measurements and electric design, that a photometer bench 140 feet long can be obtained for the measurement of powerful light sources. This floor also contains a room for physical research and a large drawing room for electric design.

The laboratory equipment includes a cathetometer, dividing engine, astrononomical clock, chronograph, standard barometers, five Becker and two Sartorius balances, special apparatus for measuring modulus of elasticity, modulus of torsion, and co-efficient of expansion, Barus calorimeter, Chatelier pyrometer, Hilger spectrometer; Zeiss spectrometer, Rowland plane and concave gratings, Schmidt and Haensch polariscopes, Zeiss microscope, Abbe refractometer, and Michelson interferometer.

**Photometer Rooms.**—The photometer rooms are equipped with Reichsanstalt photometers and have all the necessary attachments for standardizing and measuring mean horizontal or mean spherical candle power of arc and incandescent electric lights and other light sources. On each floor there is a room for the storage of apparatus. These rooms are connected with an electric elevator, greatly facilitating the transfer of apparatus.

**Object of Instruction.**— The studies of the course in electrical engineering are designed to secure to all the graduates a professional preparation at once thorough and practical for the following specialties in engineering practice:

The design, operation, testing and applications of direct and alternating current machines including generators, motors, frequency changers, rotary converters, transformers, switchboards and other appliances; the design, con-



Generators and Motors

struction, equipment and operation of central power plants including foundations, buildings, electrical and steam or hydraulic equipment and complete tests of all classes of power house machinery; hydraulic power developments; the design and construction of underground and overhead systems for the transmission of electrical energy and its distribution for light, heat and power purposes; electric railway systems including their layout, roadbed, track and line construction, car eqiupments and signal systems; the application of arc and incandescent lamps to interior and street lighting, including the design of interior lighting systems; telephone and telegraph systems, including switchboard and line construction; storage batteries; the application of electricity to chemical processes; the selection and tests of the various materials used in electrical engineering; the preparation of specifications, bills of material and contracts; the operation of electric light and traction companies, including the determination of operating costs and the establishment of rates and schedules.

## COMMENCEMENT ADDRESS.

Address to the class of 1909, at Commencement, June 16, 1909, by Mr. Onward Bates:

" Mr. President, Gentlemen of the Board of Trustees and of the Faculty, Ladies and Gentlemen, Gentlemen of the Class of 1909.— The honor of delivering the commencement address this year might, with propriety, have been reserved for a Rensselaer graduate. It was with mixed feelings that I considered the invitation to address you. I felt it should be tendered to one who is more of a scholar and that I was not competent to do justice to the occasion, but I concluded I would place the responsibility for the selection with your president. I reflected that perhaps his judgment was correct in choosing a man whose only claims for recognition are that he has performed the ordinary service of a working lifetime, and whose experience should qualify him to say something to the class of 1909 which will help them in the experiences that are before them. It is particularly gratifying to me that, having endeavored to correct a deficiency of education by hard, practical work, I am thought to be worthy of this honor and that I am thus recognized by the one great school of engineering which holds in my mind the first rank. In addressing you as a practical engineer and basing my remarks upon practice, much of what I have to say will be

Lecture Room, Physics and Electrical Engineering

my own conclusions, drawn from individual experience, and I will therefore use the personal pronoun and speak to you as man to man, without attempting the formalities of a literary address. Personal testimony is the most effective, and if I talk too much of myself it is only to interest you and to emphasize the thoughts I wish to convey.

"First of all, let me say something of my experience with the Rensselaer Polytechnic Institute to confirm your faith and to influence all present and future students who hear this experience to have a proper respect for the curriculum of the Institute. As a boy I learned the trade of pattern-making, and then was employed for about three years on the St. Charles and St. Louis bridges, after which I came to Troy, by the advice of my friend and professional father, the late distinguished engineer, C. Shaler Smith. I make this digression and bring in the name of Colonel Smith by way of testimony to the reputation of Rensselaer Polytechnic. He, in common with many other eminent engineers who had not the advantage of such a course of instruction as was offered by Rensselaer, was numbered among its supporters, and selected it as the best place for his young friends to learn the theory of the profession.

"Upon my arrival at Troy I went to see Professor Drowne, at that time the Director of the Institute, and told him I wished to study for two years, taking a special course. Professor Drowne reasoned with me and urged me to enter as a regular student for the whole course, but I was stubborn and insisted I would take a special course or none at Troy, and I was reluctantly permitted to enter as a special student. I had been at work, had drawn salaries and to some extent been recognized as a man among men, and it seemed to me that life was too short for me to spend four years of it as a student. I was in my twenty-second year and had the civil privileges of manhood and could not make up my mind to devote four years solely to what I thought was non-productive work. Herein is the justification of this personal narrative. In my youthful conceit I set my opinion against that of older and wiser heads who knew what I did not, the value of preparation. I frequently met Professor Drowne, and he tried to show me the truth of the matter, but I held to my opinion and made the greatest professional error of my life.

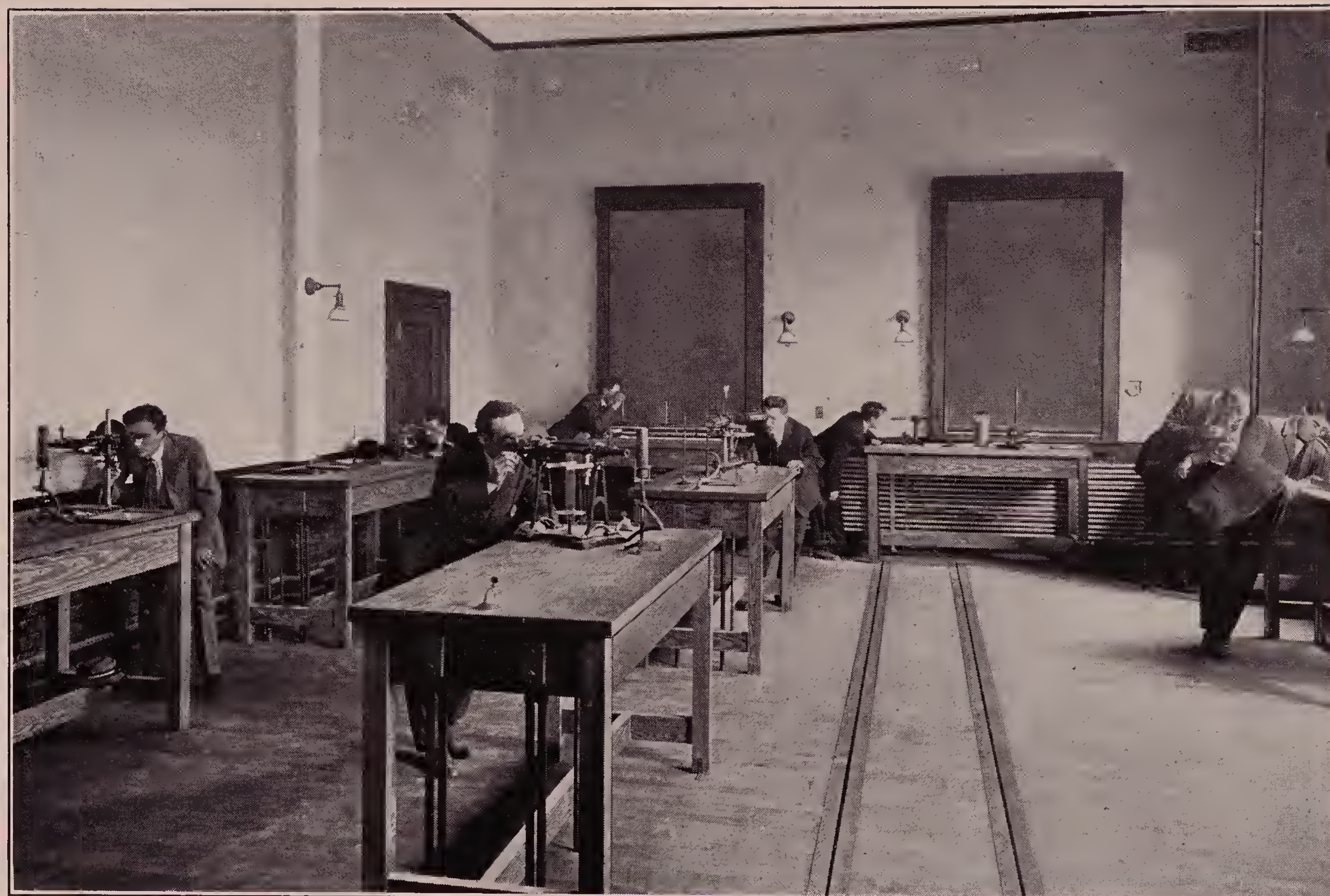
"I entered Rensselaer in 1871, with the class of '75 and closed my R. P. I. career in June, '73, thirty-six years ago. Gentlemen, I can scarcely realize that I am talking to men who were not even to be considered at that time. What

Electrical Measurements

an old man your honored President must be, for he was a classmate of mine. I trust you give him the reverence due to his age. Only two years for me at Troy, with happy memories attached to them, but for more than thirty years with regrets that I am not a real Troy man. I miss my place in the R. P. I. family; I miss the right to say that I am a civil engineer because I hold the R. P. I. degree; and, most of all, I have continuously missed the engineers' equipment of scientific training which Rensselaer gives and guarantees by her degree. Ever since I left Troy I have been handicapped by the loss of half the course of study. I have burned the midnight oil and, as a student and reader have tried to make up for that loss with only partial success. I am devoted to the profession, and yet I constantly face the restriction of qualifications which is the result of refusing to take Professor Drowne's advice. I have only the consolation that I have done what I could to correct this error of youthful inexperience, and am willing to confess this weakness for the benefit of those who must consider the question of education.

"I say to all young men who have the privilege of choosing a university course, and particularly to those who enter the Rensselaer Polytechnic Institute, to be wise in adopting the advice of others, gained by experience, and to accept the whole curriculum. Do not be deceived with the idea that it is a loss of time. You do not deserve to be an engineer if it is not your aim to end at the top of the profession. and you may be assured that nothing contributes so much to progress as a proper equipment for the journey.

"Gentlemen, I envy you the opportunities you have enjoyed, and trust that you have made good use of them. This day closes the course of your instruction at Troy. You will no longer have the corps of able and devoted professors and instructors to explain and lead your minds into the knowledge of the Science of Engineering. They have endowed you with this knowledge which in future will be your stock in trade, and they send you out to take your places among men to do men's work, to make the world better and by your work and lives to maintain the honor and renown of your Alma Mater. You have had exceptional opportunities in the way of preparation for the engineers' work. You have the inspiration of the work of previous graduates who have made the name of Rensselaer famous, causing the letters 'R. P. I.' to be magical ones in the engineering world. Consider now what is expected of you. In taking the R. P. I. degree you have accepted an

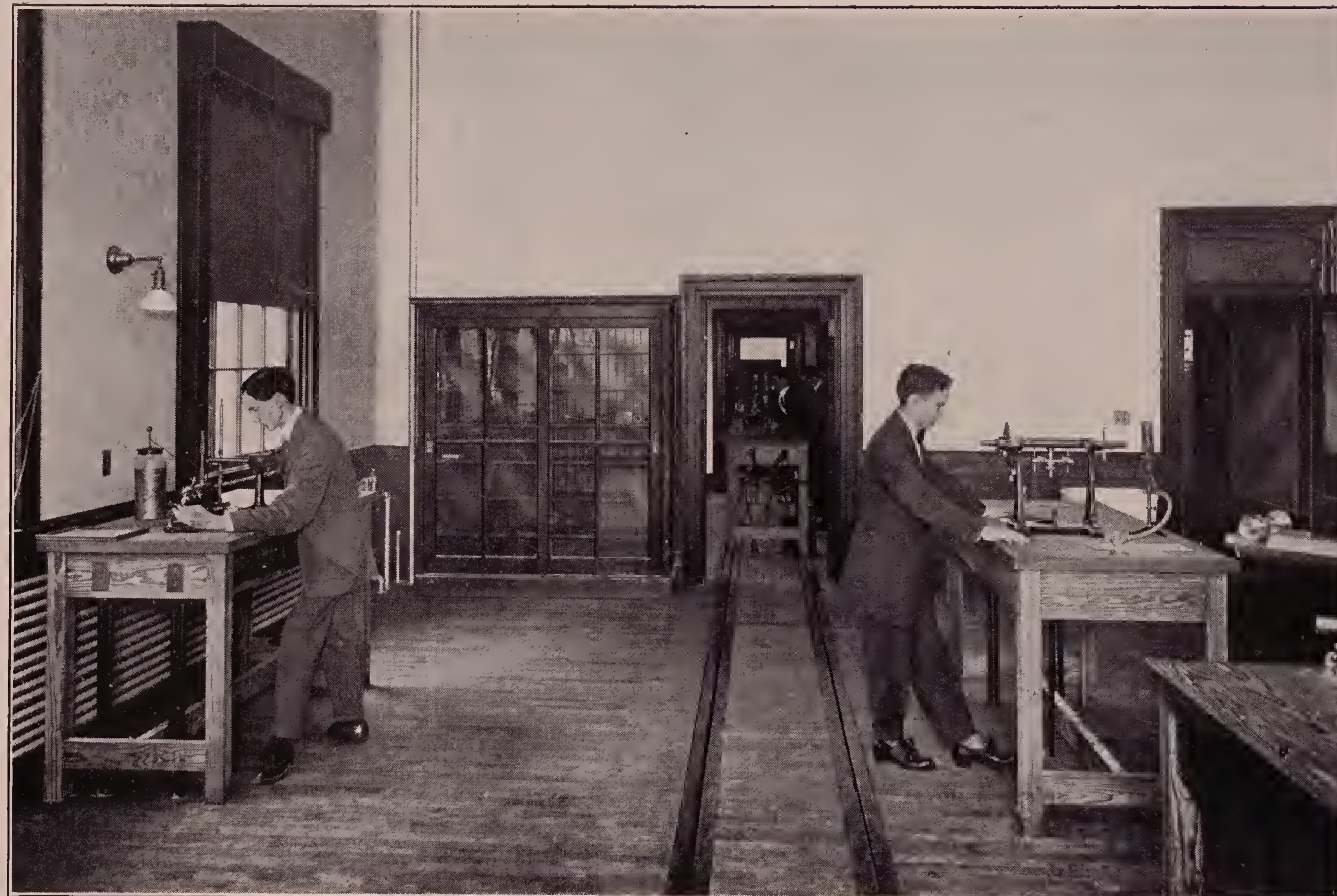


Measurements in Light

office with a duty attached to it. This degree confers a trust to which you must needs be faithful, and you can not escape it. Your certificate from R. P. I. weds you to the engineers' profession and lays on you the requirement of service to the world which gives you, through your Alma Mater, the qualifications and commission for that service.

"But do not be led astray by the events of this day. Your degree does not make you an engineer. It only certifies that you have an engineering education and are now prepared to learn the practice of the profession. The engineer is the product of practice. His college education is his kit of tools to be used in his practice. He is not like a merchant who buys and sells, for he is a creator, a builder of actual visible things. Neither is he like a workman who learns how to make particular things and continues to make similar ones. The engineer makes things which are different from each other, and as he grows he makes more and greater things than before. He has acquired his tools at college, and in practice he learns how to handle these tools and to use them in his creations. With increasing skill in handling tools he must increase his kit both in number and in quality. The moral of this is that he must always be a student as well as a practical worker, and that his training in college is only the first stage of his professional education. A short time ago an engineer, who stands second to none, was showing me a great engineering work, and my enthusiasm over what had been accomplished led me to exclaim: 'If an engineer could only practice his profession a thousand years he might reach some stage of proficiency in it;' when my friend immediately replied: 'Yes, and if he did not learn a great deal in the last year he could not consider himself an engineer.' Another eminent engineer recently wrote me regarding a man whose early life was very promising and who disappointed his friends in later life, that 'he should, and I believe could, have reached the very first rank of his profession, but, like so many others whom we know, he did not keep up after he left college the habit of incessant hard study and application necessary to insure success in the profession.'

"These quotations are given to show that engineers who are regarded as leaders in the profession regard themselves as only beginning to acquire the knowledge of it. Such is the beauty of the profession; it is inexhaustible, and, to one with a true engineering spirit, there are always remaining achievements which are yet to be accomplished. To be successful an engineer requires the possession of such a



Photometric Rooms, Showing Long Photometer Track

spirit, for if his success is measured solely by its return in money or popular esteem, he will be disappointed. Even an R. P. I. graduate can not expect to begin at the top, and in all probability must start at the bottom in the practice of the profession. This is as it should be, in order that he may have the enjoyment of continued progress. Beginners in practice are employed for salaries. This can scarcely be otherwise, for they get their training in the early part of their practical life under the direction of more experienced engineers. The majority of engineers are salaried men; even the high grade of chief engineers are employed for salaries. Independent practice, especially that of consulting engineers, properly belongs to those who have, by long experience, qualified as advisers. It is to be regretted that men who are not qualified sometimes establish themselves as consulting engineers, but there is no law to prevent this and an engineer is fairly well protected by his reputation for actual performances. No pity need be wasted on clients who employ incompetent engineers without first ascertaining their reputation.

" If I were to attempt the division of an engineer's years under existing conditions I might say that the first twenty-five years should be devoted to preliminary education, the next fifteen years to practical education, the next ten years to remunerative practice and the next ten years to advisory work. This would give him sixty years and the years after that could be devoted to study and repose, with sage advice when required for important matters, and to the encouragement of those coming on after his time. Thus all through his life he will have the enjoyment of acquiring knowledge and of making practical application of it. Perhaps this will seem too slow for you, or maybe you wish to get rich and enjoy spending money. Well, if your desires lie in that direction you may question whether engineering is your vocation, for there are surer and quicker ways of making money than in the practice of engineering and it may be admitted at the start that the profession is a poorly paid one and that its rewards lie more in its accomplishments than in its pecuniary returns.

" Let it be granted that you start at the bottom, working for a small salary, and under orders from others. This is right, but it is not right for these conditions to continue any great length of time or the engineering principle of progress is defeated. The question is how to make this progress. Let us consider what you should do. Do the work laid out for you faithfully and do it well. Do not limit yourself to

Electrical Design Drawing Room

simply what is required of you. Always do more than is expected of you. Show yourself capable of doing better work than that allotted to you. Mark my words, that the man who will do these things will get better work and better pay and will progress and have others following him, whose work he will supervise. At this point in your education you will undertake new courses of study in the school of practical experience. Everything which you see done, and especially those things you do yourself or have done under your direction with responsibility for results, will have lessons for you to learn. This course of study is not limited by years, for it will never be completed. Remember that every stick and stone has its lesson, that every movement is right or wrong, that every man has some knowledge and skill you do not possess and that every occasion is open to you for the acquirement of knowledge and improvement in its application. Do not fear to show your ignorance nor to avail yourself of the knowledge of others. You can ask questions of the man with the pick and shovel without sacrifice of dignity or loss of authority. The test of an engineer is that 'he shall be qualified to design as well as to direct engineering works.' You can not direct engineering works unless you know how the work should be done, and you require this same knowledge to be a competent designer. It is probable that men who do the work under your design and direction will understand better than you do how it should be done. The proposition is a simple one: you must learn what they know and use that knowledge both in designing and directing. Some engineers who have reached distinction in special lines have made it a habit to consult contractors and workmen respecting the facility of execution and the ultimate value of designs, and have introduced their suggestions into the working plans before signing them as complete. These same engineers would go farther and change their designs after they were adopted if it was shown to them that such changes were desirable. No man loses prestige by accepting good advice and giving credit where it belongs, though he may easily do so by stealing the ideas of others and palming them off as his own. In the one case he will be credited with the possession of good judgment and in the other case he will surely be found out and will not even get as much credit as he deserves. It will be of no use for him to claim credit which is not due him, for though he might deceive the public he can not hoodwink his brethren. It is in the nature of the profession to search for truth and to judge

THE 600,000 POUND TESTING MACHINE

from facts, and we form our estimate of a man from what he is, what he has done and what he can do. The right thing is to forget self and put your whole mind into your work without discounting the credit you may get for doing it.

" Engineering knowledge is acquired step by step. What one engineer successfully performs is the foundation for a succeeding engineer to build upon. Observe what other engineers have done and are doing, and begin where they leave off. Independent thought and action is desirable when it is in advance of what has already been accomplished and it is wasted when it follows in the rear of what has been done by others.

" The engineer in his work has use for all of his faculties. Each of his senses comes into action in enlightening his mind, which analyzes and determines the evidence for the solution of his problems. In your classrooms, shops and laboratories you have learned to what use the senses may be applied. Seeing, hearing, feeling, smelling and tasting — all have a part in your education, sometimes a disagreeable part; for instance, you may have to tackle some foul-smelling job where your nose will be offended. It is necessary to discriminate in the use of the senses. This is illustrated in a case where an engineer was sent to examine a timber structure. He took accurate measurements of the structure and made a correct drawing of it, but when he was asked if the timber was pine or oak he said he did not know, that he felt it and it felt very hard. Obviously, the sense of seeing would, in that instance, be more serviceable than that of feeling. I wish to emphasize the importance of seeing, observing and remembering, and for this purpose will draw the moral from my own experience. After being employed for some years in shops and on particular bridges, I was called to take charge of all structures on a railway system with more than 6,000 miles of lines. It was my duty to pass on questions of maintenance, changes, renewals and improvements for some thousands of bridges and culverts, with structures of every kind, at more than thirteen hundred stations. It was essential that I should be informed of the condition of each of these structures, and my first desire was to see them all. If I could cover 200 miles a day on an inspection trip, it would take more than thirty days to go over the road. One of the first inspection trips consumed ten days, during which I used my eyes and my note book. I found in trying to remember what I had seen in those ten days that my head was in a complete jum-

Class of 1909 with some of the Faculty

ble, and for the first time I became aware that my education as an observer had been neglected. I felt this so keenly that I made an earnest and continued effort to acquire the habit of seeing and remembering, and, although I could not entirely overcome my previous neglect, I was able in the course of years to perceive a great improvement in this respect. My advice to you is that you cultivate this habit from the beginning of your practical work and continue it through life. This will give a fund of experience, worth having for your own satisfaction, and of money value to you as a consulting engineer.

"In addition to the five senses already mentioned, there is a sixth sense, the value of which is inestimable and which is indispensable for the equipment of a complete engineer. You, of course, understand that I refer to common sense. This sense teaches you to weigh and place the correct value on all that you learn through the other five senses. May I call your attention to two frequent errors for which common sense is the remedy? One of these is the popular fallacy that knowledge is acquired by talking, and that speech is one of the senses, whereas common sense informs us that speech is frequently nonsense, and that at best it only imparts knowledge to others who appropriate it through the sense of hearing. The other error is the tendency to accept statements as facts, simply because they proceed from certain sources. Common sense teaches one to discriminate in the study of information, and to judge between apparently conflicting statements of facts. It is not uncommon for an engineer, especially if he is fresh from the university, to place too great reliance on the accuracy of mathematical processes and misapply them in application. I have known an able man to risk his reputation in the defense of mathematical conclusions, based on assumptions which common sense should have informed him were incorrect. Another man of extended experience has limited his ability by an undue reverence for printed matter. A statement of a writer in the Engineering News, or the American Society transactions, was of more value to him than the evidence of practical men, supported by his own observations. Common sense would suggest that perhaps the writer's opinion on the subject in question was not founded on experience, and that it was an individual opinion for which his publisher assumed no responsibility.

"Another subject of study has been much neglected in our profession. That is the study of human nature. If I may be permitted to criticise professors and practicing


Class of 1909

engineers, I will say their weak side is their lack of the knowledge of human nature. They seem to know more of, and attach more importance to, wood nature, and steel nature, and stone and cement nature than to human nature; and are at a disadvantage in dealing with their employers and employees, and others with whom they have business or diplomatic relations. This is particularly unfortunate with engineers. as it interferes with their accomplishments and with their remuneration. To employers belong respectful service, but an engineer need never sacrifice his convictions in that service, nor should he fail to influence and instruct his superiors within the limits of their relationship. If he thinks he has ground for reasonable criticism, with suggestions for improvement, in any matters for which he is held wholly or partially responsible, he should criticise and suggest. He may do this in a perfectly modest and unobtrusive manner, if it is done with the sole purpose of insuring better results. Any right-minded employer or superior officer should welcome suggestions for the betterment of the service by promoting efficiency or through a saving in time or cost, and while it is not suggested that you should be unduly forward in such matters, it is really your duty to lose no opportunity in promoting the good of the work with which you are connected. Should your employer or superior take offense in such a case, the fault is theirs and not yours. Be contented, but always looking for improvement in your position. Men are made by having opportunities and using them. You can go one step farther and make these opportunities. Be bold, and assume obligations when you can assure yourself that you are able to meet them, but do not be rash in assuming to do what you cannot reasonably expect to achieve.

" With regard to all men, and especially to those whom you outrank, remember that all are entitled to respect until they have shown themselves unworthy of it; that in some ways all men are equal; and that by recognizing and giving every man his rights you will always obtain the best results. We hear a common expression regarding someone, that ' he knows how to handle men.' This is one of the chief elements of success, whether you are using their scientific knowledge, their business capacity or their physical strength and the engineer who can not get the best out of the men of every degree who are subordinate to him, will not be able to secure the results which he owes to his employers and to himself. One of the most frequent examples of the weakness of engineers in dealing with men is found in their relations


Class of 1910

with contractors. It is common for engineering work to be done by contract under the supervision of engineers, and the control of the work and settlement of accounts is a fruitful source of trouble to the engineer. In the first place engineering contracts are nearly always wholly one-sided, being drawn by the engineer or his employer, and reserving all rights and privileges that are possible for their side, while giving the contractor as few as possible. It is proper enough that the engineer should be the one to decide points of dispute with the contractor, and this places with him an extra responsibility, making him both an interested party and a judge of questions in dispute. It takes a high-grade man to meet such a situation with justice and to secure the harmonious co-operation of the contractor, which is necessary to good results for both parties. It is here where it becomes evident that the engineer should be a judge of human nature, knowing how to deal with men, and that he should be endowed with common sense, tact and justice, and with a conciliatory spirit. There is much unnecessary friction between engineers and contractors, and I think this oftener happens with young engineers than with older ones. Young engineers are apt to lay too much stress on the contract clauses, giving them practically unlimited power over the contractor, and to become arbitrary in dealing with him. The safe rule is to look at both sides of the question and then do what is right. As his judgment matures with age, he becomes more considerate. It is a good thing for an engineer to have some experience as a contractor, or in the service of one, for it gives him a better grasp of the rights of both sides in a controversy. It is also well to study the work from a contractor's standpoint, to get correct ideas of cost, and to learn how to handle men. The recent progress of engineering construction has made such difficult problems for the contractor that his class is best recruited from the ranks of engineers. The engineer's education, supplemented by business knowledge, and the ability to handle men, makes the ideal contractor. For this reason the contractor's occupation offers an attractive field for engineers, and it is becoming common to find them engaged in it. With the great works carried on in these days, it is frequently the case that as much engineering talent is required in construction as in the making of plans. In such cases the engineer shares in the financial risk, and if successful his reward is greater than when employed under a salary. The old idea that engineers are saints and contractors sinners is going out of


Class of 1911

fashion. The men are the same under either title, and engineers become contractors without loss of self-respect, and without losing their rank as engineers. In any case you should study human nature, for you require the knowledge of it in dealing with your superiors, your equals and your inferiors.

"The every-day quality of good judgment is of more value than all else in dealing with men, materials and processes; and professional knowledge, supported by this quality, should make an engineer the highest type of manhood.

"It is a great thing to be a successful engineer and to do one's share of engineering work, but we must guard against being too much interested in ourselves. The engineer's occupation is more or less a solitary one, with his mind so fixed on doing his own work that he is liable to forget the relations he should maintain with his fellowmen, and his duties to society. It suits very well, with my previous advice about studying human nature, to tell you to cultivate the society of others, to remember that you have duties to perform as a citizen, and that your profession does not relieve you from the duty of making others happy through social intercourse. You are also charged with a duty to the profession, to contribute in every way you can to its advancement, and to promote the welfare of its members. As you have an opportunity, it will be good for you to have membership in the local and national engineering societies. You will reap advantages from this membership, and it will afford you opportunities to do service for others.

"I will say in conclusion, keep green the memories of your days at Troy, and do not forget your associations here, nor your obligations to your instructors. The memory of your R. P. I. life will be a permanent asset, contributing to your profession in such a way as to be an honor to your Alma Mater."

Class of 1912

# TITLES OF THESES

OF THE

# Graduating Class of 1909

READ AT ALUMNI BUILDING

Wednesday, Thursday, Friday, Saturday and Monday

June 9, 10, 11, 12 and 14, 1909.

1. Design for a Six Story Reinforced Concrete Cold Storage Plant, 80 ft. x 125 ft.
   WALTER ABBE, JR., Brooklyn, N. Y.
2. Design for a Locomotive Erecting and Machine Shop, 128x400 ft., with a Crane of 120 Tons Capacity.
   WALTER RUSSELL ABBOTT, Watervliet, N. Y.
3. Design for a Double Track, Riveted, Deck, Pratt Truss Railroad Bridge with a Steel Floor System. Span 172 ft.
   WILLIAM JOHN ABBOTT, Smyrna, N. Y.
4. Design for a Separate System of Sewers and Disposal Plant for Highland Falls, N. Y. Population 10,000.
   JOSEPH HENRY ADOLPH, Highland Falls, N. Y.
5. Design for a Double Track, Through, Pratt Truss Railroad Bridge. Span 175 ft.
   LANGFORD TAYLOR ALDEN, Troy, N. Y.
6. Design for the Steel Frame of a Marble Mill, 70 x 420 ft., with a Crane of 30 tons Capacity.
   ERVIN WILBER ANDREWS, Wallingford, Vt.
7. Design for a Separate System of Sewers and Disposal Plant for Rensselaer, N. Y. Population 15,000.
   HILEY NEWTON ARMER, Ballston Spa, N. Y.

8. Design for a Double Track, Through, Riveted, Railroad Bridge with Polygonal Upper Chord and Secondary System. Span 186 ft.

CHARLES DAVID BABCOCK, Cattaraugus, N. Y.

9. Design for the Proposed Dry Dock No. 5, at the Brooklyn Navy Yard. Dock 1,000 ft. long.

ALBERT ASA BAKER, Antrim, N. H.

10. Design for a Separate System of Sewers for the Southern Part of Utica, N. Y. Drainage Area, Three Square Miles.

JOHN HENRY BALDWIN, New Orleans, La.

11. Design for a Single Track, Through, Riveted, Quadrangular Truss Railroad Bridge with Secondary System and Trough Floor. Span 165 ft.

JAMES RAYMOND BARNARD, Honeoye Falls, N. Y.

12. Design for a Single Track, Through, Pin Connected Draw Bridge. Span 255 ft.

PENDLETON BEALL, San Antonio, Texas.

13. Design for a Double Track, Through, Riveted, Quadrangular Truss Railroad Bridge with Secondary System. Span 180 ft.

WILLIAM BEIERMEISTER, Troy, N. Y.

14. Design for a Separate System of Sewers and Disposal Plant for the City of Sagna, Cuba, Population 10,000.

EMANUEL LEO BOLANO, B.A., Mantanzas, Cuba.

15. Design for a Two-Story Steel Warehouse and Dock. Warehouse 98 x 760 ft. Dock 112 x 790 ft.

CHARLES FOWLER BORNEFELD, Galveston, Texas.

16. Design for the Development of the Water Power at Salmon River Falls, and its electrical Transmission to the West Shore Railroad between Utica and Syracuse, N. Y. 12,000 H. P.

TIMOTHY JAMES BUCKLEY, Altmar, N. Y.

17. Design for a Separate System of Sewers and Disposal Plant for Amsterdam, N. Y. Population 10,000.

CHARLES DOW CALKINS, Troy, N. Y.

18. Design for the Steel Frame of a Mill Building, 110 x 300 ft., with an Electric Crane of 40 tons Capacity.

HAROLD EDWIN CURTIS, Troy, N. Y.

19. Economic Study of a Pipe Line for Crude Oil, together with Pumping Stations, between Mooringsport, La., and Port Arthur, Texas. Distance, 200 miles.

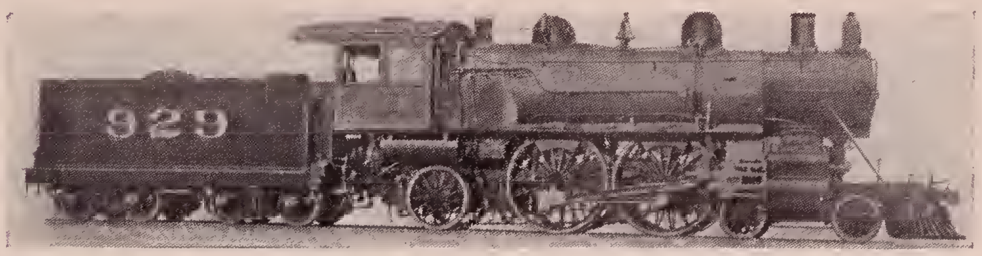
ALLEN STEWART DAVISON, Pittsburg, Pa.

20. Design for a Single Track, Through, Pratt Truss Railroad Bridge, with Secondary System.. Span 192 ft.

RAYMOND EDWIN DEMMING, Lyons, N. Y.

21. Design for a Separate System of Sewers and Disposal Plant for Seneca Falls, N. Y. Population 12,000.

JOHN HENRY EGLOF, Troy, N. Y.




22. Design for a Bascule Bridge of the Strauss Type to replace the present Draw Spans of the N. Y. C. & H. R. R. Co. at Albany, N. Y. Span 174 ft.

WILLIAM CHESTER EMIGH, North Adams, Mass.

23. Design for a Water Tower, Tank and Pump; Height of Tower, 100 ft.; Diameter of Tank, 14 ft., Height, 20 ft.

OLNEY NORMAN FOOTE, Mount Morris, N. Y.

24. Design for the Steel Frame of a Ten-Story Office Building, 60 x 90 ft.

STEWART EUGENE FROST, Brattleboro, Vt.

25. Design for a Granite and Concrete Graving Dock, and Protection Works for Excavation. Dock 1,000 ft. long by 36 ft. deep.

ROBERT SAMUEL FURBER, Northfield, Minn.

26 Design for the Steel Frame of a Twelve Story Office Building, 75 x 100 ft.

WILLIAM FREDERICK GEIGER, Troy, N. Y.

27. Design for a Separate System of Sewers with two Pumping Stations and Disposal Plant for Woodmere, L. I. Population 10,000.

LESLIE PAUL GIFFORD, Valley Falls, N. Y.

28. Design for a Single Track, Deck, Riveted, Quadrangular Truss Railroad Bridge, with Secondary System and Wooden Floor Span.

RALPH ADOLPHUS GOVE, Jr., Loudonville, N. Y.

29. Design for a Reinforced Concrete Grain Elevator and Power Plant.

HARRY RIDDELL HAYES, Utica, N. Y.

30. Design for the Elimination of the Grade Crossing at the Intersection of the N. Y., N. H. & H. R. R. with Center and West Park Streets, at Lee, Mass.

HARRY WILLIAM HEAPHY, Lee, Mass.

31. Economic Study for Determining the Feasibility of Eliminating the Hogback Summit of the Buffalo and Susquehanna Railroad by means of a Tunnel.

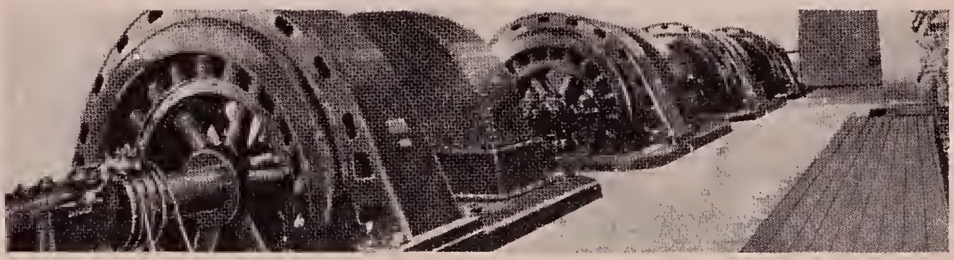
BYRON VOLTAIRE HERDEN, Wellsboro, Pa.

32. Design for a Roller and Ice Skating Rink, including an Ice Plant. Building 90 x 200 ft.

GEORGE HOLLAND JONES, Albany, N. Y.

33. Design for a Through, Highway, Pin Connected Baltimore Truss Bridge. Span 210 ft.

ELDA LOUIS KIMMEY, Troy, N. Y.



34. Design for a Separate System of Sewers and Disposal Plant for Blankville, N. Y. Population 10,000.

CHESTER SHERMAN LEE, Troy, N. Y.

35. Design for a Separate System of Sewers and Disposal Plant for Fulton, N. Y. Population 15,000.

EDMOND FITZGERALD LUDDEN, Troy, N. Y.

36. Design for a Separate System of Sewers and Disposal Plant for El Carro, Havana, Cuba.

JOAQUIM MARIA MANZANILLA, Havana, Cuba.

37. Design for a Double Track, Riveted, Pratt Truss Railroad Bridge. Span 162 ft.

JOSEPH JUSTO MANZANILLA, Havana, Cuba.

38. Investigation Concerning Hardness of Filter Sands, and Notes upon Sundry Water Supply Questions.

ALFRED KINGSLEY MARTIN, C.E., Troy, N. Y.

39. Design for a Separate System of Sewers and Disposal Plant for Haverstraw, N. Y. Population 12,000.

FRANK WILLIAM McCAULEY, Haverstraw, N. Y.

40. Design for a steel Viaduct across Cotton Factory Hollow to connect Mount Pleasant and Schenectady, N. Y. Length 650 ft.

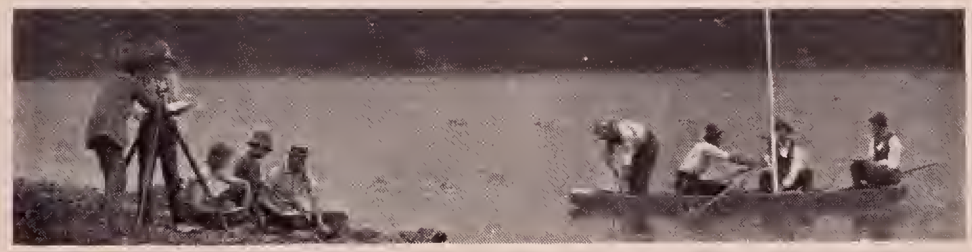
FREDERICK STEWART McCUNE, Schenectady, N. Y.

41. Design for a Double Track, Pin Connected, Through Railroad Bridge with Polygonal Upper Chord. Span 240 ft.

CROSBY JAQUITH McGIFFERT, Kingston, N. Y.

42. Design for a Separate System of Sewers and Disposal Plant for Circleville, Ohio. Population 14,000.

LOUIS ZEREGA MEARNS, Troy, N. Y.



43. Design for a Separate System of Sewers and Disposal Plant for Sandy Hill, N. Y. Population 12,000.

CHARLES EDWARD MERRITT, Marlboro, N. Y.

44. Design for a Steel Light Station for Lloyd Point, Long Island Sound. Height 127 ft.

HERBERT EUGENE MILLER, Whitestone, N. Y.

45. Design for a Single Track, Deck, Pratt Truss Railroad Bridge. Span 168 ft.

MALCOLM STAATS MILLER, Castleton, N. Y.

46. Design for the Steel Frame of an Office Building, 75 x 135 x 87 ft. high.

JOSEPH EDWARD MINCHER, Cohoes, N. Y.

47. Design for a Deck, Riveted, Warren Truss, Highway Bridge with Sub-verticals and Buckle-plate Floor. Span 155 ft.

GEORGE ROLAND MOORE, Manasquan, N. J.

48. Design for a Separate System of Sewers and Disposal Plant for Flushing, L. I. Population 15,000.

LEONARD KYRAN MOYLAN, Troy, N. Y.

49. Design for a Hydro-Electric Power Plant on Rondout Creek, at High Falls, N. Y. 1,200 H. P.

JOHN CARLETON MURRAY, Delhi, N. Y.

50. Design for a Double Track, Through, Riveted, Railroad Bridge with Curved Upper Chord. Span 184 ft.

THOMAS STANLEY O'BRIEN, JR., Albany, N. Y.

51. Design for a Separate System of Sewers and Disposal Plant for North Plainfield, N. J. Population 12,000.

CHARLES WING PARSONS, Albany, N. Y.

52. Design for a Single Track, Railroad Viaduct 552 ft. long, consisting of Plate Girders and one Deck Pratt Truss.

GUY MERRITT PHELPS, Glens Falls, N. Y.

53. Design for a Draw Bridge with Inclined Upper Chord and Secondary System to replace the present Draw Spans of the N. Y. C. & H. R. R. Co. at Albany, N. Y. Length of Swing, 368 ft.

WILLIAM JOSEPH POPP, Albany, N. Y.

54. Design for a Double Track, Deck, Riveted, Railroad Bridge, with three Warren Trusses, Subverticals and Wooden Floor System. Span 162 ft.

JOHN MURRAY PRIOR, Albany, N. Y.

55. Design for the Hydro-Electric Power Development of the Deerfield River at Shelburne Falls, Mass. 2,500 H. P.

LOUIS BLACKMER PUFFER, Bennington, Vt.

56. Design for the improvement of Atares Bay, Havana Harbor, Cuba, consisting of Sea Walls, Dredging, Dock and Warehouse 64 x 192 ft.

FRANCISCO PUJALS Y CLARET, Havana, Cuba.

57. Design for a Steel Mill Building, 198 x 130 ft., with a Crane of 40 tons Capacity.

HORACE WAYLAND RINEARSON, Hamilton, O.

58. Design for a Separate System of Sewers and Disposal Plant for Fort Edward, N. Y. Population 10,000.

WILLIAM ARTHUR ROGERS, Fort Edward, N. Y.

59. Design for a Separate System of Sewers and Disposal plant for Mitchell, S. D. Population 10,000.

EDGAR KINGSBURY RUTH, B.S., Mitchell, S. D.

60. Design for the Steel Frame of a Twelve Story Office Building, 75 x 150 ft.

JAMES FRANCIS SCANLON, Plattsburg, N. Y.

61. Design for a Steel Mill Building, 90 x 192 ft., with a Crane of 40 Tons Capacity.

HORACE LESLIE SCOTT, Brattleboro, Vt.

62. Design for the Development of the Water Power of the Genesee River near Portageville, N. Y. 20,000 H. P.

WALTER VANDERBILT SCOTT, Geneseo, N. Y.

63. Design for a Single Track, Through, Triple Intersection Riveted Railroad Bridge. Span 168 ft.

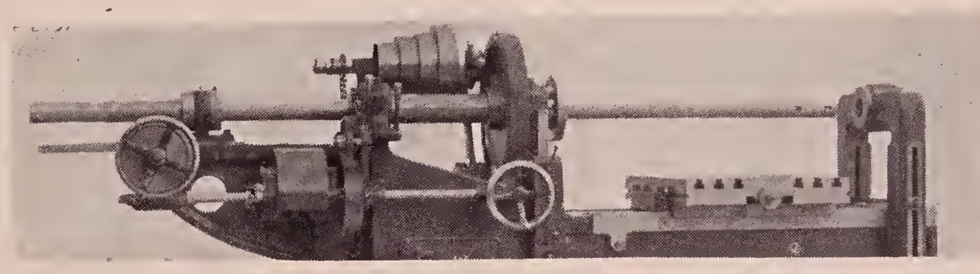
ROBERT ASHLEY SEARLE, Troy, N. Y.

64. Design for a Reinforced Concrete Arch Bridge. Span 125 ft., width 56 ft., rise 18 ft.

RALPH GRAHAM SHANKLAND, Chicago, Ill.

65. Design for an Electrical Power Plant for the United States Naval Station at Guantanamo, Cuba. 3,000 H. P.

NORMAN MURRAY SMITH, Williston, S. C.



66. Design for a Lift Bridge to replace the present Draw Spans of the N. Y. C. & H. R. R. Co. at Albany, N. Y. Span 175 ft.

JOHN HENRY SPENGLER, Kansas City, Mo.

67. Design for a Single Track, Railroad Viaduct, consisting of two Deck Warren Truss Spans and four Plate Girder Spans. Total length 630 ft.

WILLIAM MATTHEW STIEVE, Albany, N. Y.

68. Design for the Steel Frame of an Eight Story Office Building, 42 x 120 ft.

KARL OTTO STRENGE, Albany, N. Y.

69. Design for the Elimination of the Grade Crossing at Culver Road, Rochester, N. Y.

LOUIS PAUL STUTZ, Albany, N. Y.

70. Design for a Concrete Dam and Locks with Operating Machinery, on the Monongahela River at Brownsville, Pa.

OTTO JORDAN SWENSSON, Pittsburg, Pa.

71. Design for the Power Development of Boulder Creek, Boulder, Col. 20,000 H. P.

DAVID BRIER TAYLOR, Washington, D. C.

72. Design for a Three Hinged Steel Arch Roof Truss. Span 150 ft., rise 60 ft.

HENRY LOUIS THIESSEN, Troy, N. Y.

73. Design for a Separate System of Sewers and Disposal Plant for the Bay Ridge section of Brooklyn, N. Y. Population 50,000.

MAURICE LESTER TROEGER, New York, N. Y.

74. Design for a Separate System of Sewers and Disposal Plant for Waterford and Northside, N. Y. Population 10,000.

EDWIN GORDON VAN DERWERKEN, Cohoes, N. Y.

75. Design for a Separate System of Sewers and Disposal Plant for the Village of Mechanicville, N. Y. Population 12,000.

JOHN EDWARD WALSH, A.B., Mechanicville, N. Y.

76. Design for a Single Track, Through, Riveted, Railroad Bridge with Polygonal Upper Chord and Secondary System. Span 180 ft.

THOMAS THORPE WALSH, Baltimore, Md.

77. Design for a Double Track, Deck, Riveted, Quadrangular Truss Railroad Bridge with Subdivided Panels and Trough Floor. Span 174 ft.

THOMAS LEWIS WAY, Johnstown, N. Y.

78. Design for a Rolling Lift Bridge of the Scherzer Type to replace the present Draw Spans of the N. Y. C. & H. R. R. Co. at Albany, N. Y. Span 173 ft.

FRANK RODERIC WEAVER, Johnstown, Pa.

79. Design for the Elimination of the Grade Crossing of the B. & S. R. R. over the B. R. & P. R. R. at Sykesville, Pa.

DANIEL RISHEL WEBER, Sykesville, Pa.

80. Design for a Single Track, Quadruple Intersection, Through Railroad Bridge. Span 180 ft.

HARRY AMBROSE WILLIS, Troy, N. Y.

The Executive Committee of the Rensselaer Union

Charles Van Benthuysen & Sons,
Printers, Albany, N. Y.

ROADS RAIL ROADS BRIDGES WATER WORKS
SEWERS RIVERS CANALS ROOFS
ARCHES TUNNELS FOUNDATIONS

BOILERS STEAM ENGINES STEAM TURBINES
GAS ENGINES SHIPS HEATING
REFRIGERATION SHOP-MANAGEMENT

ELECTRIC-MACHINERY DYNAMOS TELEPHONES
ELECTRIC LIGHTING ELECTRIC-TRANSMISSION
ELECTRO-CHEMISTRY

MINERALOGY METALLURGY ASSAYING
CHEMICAL-ANALYSIS